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THE VENOPRESSOR MECHANISM

By Professor YANDELL HENDERSON

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"WE have yet to explain in what manner the blood finds its way back to the heart from the extremities by the veins." So wrote William Harvey:[1] and now 300 years later the explanation is still not wholly complete. As a major factor in the venous return, Harvey described the valves in the veins and showed, by moving a finger along a vein in the arm, that "while these valves readily open in the right direction," *i.e.*, toward the heart, they "entirely prevent all contrary motion." And he accompanied the description with a drawing, copied from Fabricius,[2] showing a man's forearm with a ligature above the elbow and the hand grasping a rod, while the veins swell. In the grip of the hand in that drawing is the first suggestion of a venopressor mechanism.

It is always dangerous to read subsequent knowledge back into the words of the first author in any field. Yet one can not resist the impression that Harvey, in this drawing along with his account of the valves in the veins, recognized that the vigorous contraction of the muscles of the forearm propels blood from the muscles into the veins and on toward the right heart. If so, he would have been entirely in accord with the modern view that any muscle that is rhythmically relaxed and contracted, so that its capillaries are alternately filled from the arteries and emptied into the veins, acts as a peripheral pump, a "booster,"[3]

[1] W. Harvey, "The Motion of the Heart and Blood in Animals." London, 1628. Chap. 13. Everyman's Library, New York, 1906. Also translation by C. D. Leake, published by C C Thomas, 1931.

[2] H. Fabricius, "DeVenarum Ostiolis," 1603. Translation by K. J. Franklin, published by C. C Thomas, 1933, pp. 80, 81.

[3] Booster: A pump used to increase the pressure of

aiding the venous return of the blood and the diastolic filling of the heart.[4]

How well the intramuscular blood vessels are arranged to act the part of such peripheral blood pumps is clearly described by Krogh.[5] He writes:

> The arteries supplying a muscle branch freely and between the branches there are very numerous anastomoses forming a primary net. . . . The capillaries unite into venules intercalated between the arterioles, and the whole system of veins reproduces and follows almost exactly that of the arteries. All the veins down to the smallest branches are provided with valves allowing the blood to flow in the direction of the heart only. When the muscle contracts its form is greatly altered, the fibers become much shorter and proportionally thicker, . . . The blood is driven out by compression from a number of the venous branches and, when the muscle relaxes again, these can be filled from the peripheral end only. Since muscular contractions usually more or less regularly alternate with relaxations the system of valves makes of the veins of each muscle a very effective pump. . . .

So the muscles provide a venopressor mechanism to meet the increased demands on the circulation which the muscles themselves create during periods of physical exertion. There can be little doubt that it is largely by such peripheral aid to the venous return that the enormous increase in the output of the heart—at least five fold—during vigorous muscular exertion is made possible.

But suppose the exertion ceases and the man stands quite still, or sits down, or lies down and rests so completely that for a time no muscle in his body makes any visible movement, or does any external work. Does the pumping action of the muscles cease entirely? Is the venous return then wholly dependent upon the vis a tergo imparted by the heart and transmitted through the arteries and capillaries into the veins, and so onward to fill and distend the right heart? In other words, to paraphrase Harvey's question, "could the blood find its way back to the heart from the extremities by the veins" without some peripheral aid? There is strong evidence that it does not, and that it could not; but that at least in health there is constantly active peripheral aid to the venous return. It is only in the state called shock and other conditions of profound physical depression that this booster action fails. The testimony now to be cited indicates that even in the most complete state of healthy rest and quiescence the muscles are still pumping and that the venopressor mechanism, as above described, is still active so long as the motor centers in the spinal cord continue to discharge nervous impulses into the skeletal muscles in the maintenance of tonus.

Muscle Tonus and its Control

Sherrington,[6] in his classic analysis of the proprioceptive reflexes by which muscle tonus, body posture and facial expression—and to a considerable extent also basal metabolism—are maintained and adjusted, showed decisively that even when the body is at rest, and appears to be entirely motionless, the skeletal musculature is far from flaccid. On the contrary, as he expressed it, "the greater part of the skeletal musculature is all the time steadily active."

More recent studies, such as those of Adrian[7] and Adrian and Bronk[8] on single nerve fibers, have confirmed the conception that the mode of behavior of all the nerve-muscle mechanisms involved in external motion and active work holds equally true of the tonic contractions of the muscles that maintain posture even in normal rest. Between the states of bodily exertion and muscular rest, apparently so different, the form of activity within the muscles is exactly the same: varying only in degree.

In the so-called "isometric contractions," that tonus maintains when a man is standing or sitting, and even when lying down, the muscles do not shorten and do no external work. They do, however, exert an elastic pull to maintain posture. A weak pull of this type, which for lack of a better term is here called tonus, is due to impulses from motor centers in the spinal cord over only a few nerve fibers which induce contractions only in correspondingly few bundles of muscle fibers; but the impulses over each of these nerve fibers and the contractions, or elastic pulls, of each of the bundles so stimulated are maximal. A stronger pull of the muscle is due to impulses over a greater number of nerve fibers and a more rapid succession of impulses in each fiber, which stimulate a greater number of bundles of muscle fibers: the bundles contracting, or pulling, not all together, but in relays and rotation.

Contrariwise, as the activity of a muscle decreases to lower and lower degrees of intensity, until it is apparently wholly quiescent and doing no external work whatever, nervous impulses pass over fewer and fewer nerve fibers from the motor centers, and fewer and fewer groups of muscle fibers are at any instant active. Yet it appears probable that no living muscle is ever allowed to cease its tonic pull completely.

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fluids. Webster's New International Dictionary. Second Edition. Unabridged, 1934.

[4] Y. Henderson, "Adventures in Respiration." Williams and Wilkins Company, 1938.

[5] A. Krogh, "The Anatomy and Physiology of Capillaries," p. 208. Revised edition. Yale University Press, 1929.

[6] C. S. Sherrington, "The Integrative Action of the Nervous System," p. 340. Charles Scribner's Sons (for Yale University) 1906.

[7] E. D. Adrian, "The Mechanism of Nervous Action." University of Pennsylvania Press, 1935.

[8] E. D. Adrian and D. W. Bronk, *Jour. Physiol.*, 67: 119, 1929.

Always a few of the motor nerve fibers to it are discharging impulses into it, and a few of its bundles of muscle fibers are stimulated to contract.

Such, as nearly as the picture can be constructed from the experimental data now available, is the state of continual internal activity which is skeletal muscle tonus. It is a state which no part of the body loses completely except at death. So long as it is maintained it involves continuance of the pumping action of the discrete muscle bundles relaxing and contracting one after the other and thereby filling, compressing and emptying their intercalated capillaries and veins in the manner that Krogh[5] has described for the muscle as a whole.

The action of these minute pumps is the principal, but not the only, aid that muscle tonus affords to the venous return. A longitudinal pull on such a structure as a muscle necessarily induces a general internal pressure; and a pressure anywhere in a system permeated with collapsible vessels containing a fluid tends to cause the fluid to flow toward any point where the pressure is lower. That is the basic conception of hydraulics and hemodynamics. If, then, the state of tonus in muscles maintains an intramuscular pressure higher than that of the atmosphere about the body, and the pressure in the thorax is subatmospheric—the two pressures together constituting the effective venous pressure—the tonic intramuscular pressure must aid the venous return that distends the right ventricle. That such intratissue pressures do normally exist is now demonstrated by a considerable literature.[9] They are measured by determining the pressures required to force a minute amount of a saline solution through a hypodermic needle into a muscle or other tissue; and the pressures so demonstrated are found to vary according to the tension on the muscles: that is, their tonus. By maintaining pressures upon other tissues, as in the abdomen, muscle tonus conserves in the capillary blood some of the energy that the heart has imparted and tends to press onward toward the veins the blood which the arterioles throw into them.

The Electromyogram

Every time that a muscle fiber contracts it manifests its activity by an electrical event, the so-called action current. If, then, a muscle such as the biceps in a man's arm containing hundreds of separate muscle bundles is maintained in a state of tonus, the number of bundles that are thrown into contraction at any instant should be revealed in the electromyogram. In other words, the number of electrical impulses appearing in such a graphic record should indicate the number of minute capillary and venule pumps that are making discharges toward the heart. If this is correct, a series of such electromyographic records made at times when the biceps is entirely immobile externally, but under different degrees of tension, should show varying degrees of electrical activity corresponding to the degrees of tension. Accordingly, at my request, my colleagues of the Section of Neuro-Anatomy have recorded the series of electromyograms which are here reproduced. They reveal that the biceps of a man lying at rest with his arm relaxed, as in the first record, or perfectly quiescent under slight strain, as in the other records, is "all the time steadily active." They show that the number of bundles of muscle fibers in a muscle that are nervously activated varies with the intensity of the longitudinal pull that the muscle maintains. And the same evidence, interpreted in accord with Krogh's description, indicates that the number of minute pumps that are actively aiding the venous return to the heart varies correspondingly.

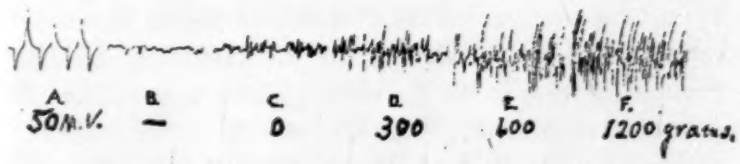

FIG. 1. Showing graphic records of the electromyogram of the biceps brachii under increasing tension: *i.e.*, the electrical discharges accompanying the contractions of an increasing number of muscle bundles and the corresponding strokes of the capillary-venous booster pumps. (A) Calibration, 50 micro volts. (B) Subject lying supine, arm beside body, biceps "at rest." (C) Biceps contracted sufficiently to hold the elbow flexed at 15 degrees. (D) Same position, 300 gram weight in hand. (E) Same position, 600 gram weight in hand. (F) Same position, 1200 gram weight in hand. Arm perfectly quiescent during the taking of each record. Records by courtesy of the Section on Neuro-Anatomy. (Graph by L. F. Nims.)

The Tonic Activity of the Motor Centers

Skeletal muscles have little intrinsic activity. Unlike cardiac muscle their behavior is imposed upon them from the central nervous system. To trace the various influences that act upon the accessory blood pumps in the muscles, we must therefore look behind the muscles to the motor centers in the spinal cord which innervate them. Yet it is only by the behavior of the muscles that we can judge how various influences affect the state of their motor centers.

As the means of testing that state two types of experiments are available. One is by means of what Sherrington has termed "proprioceptor reflexes," of which the most convenient is the knee jerk. For this

[9] Y. Henderson, *loc. cit.*, p. 243; also J. D. Kerr and L. D. W. Scott, *Brit. Med. Jour.*, 2: 758, 1938; W. Beigelbock and H. Jung, *Zeitschr. f. klin. Med.*, 131: 242, 1937; H. S. Wells and H. S. Youmans and D. G. Miller, Jr., *Jour. Clin. Invest.*, 17: 489, 1938; F. A. Hillebrandt, E. J. Crigler and L. E. A. Kelso, *Am. Jour. Physiol.*, 126: 247, 1939.

purpose the thigh must be supported and fixed in an unchanging position and the taps on the patella tendon must be applied at uniform intervals by a light hammer falling through a uniform distance. With this arrangement it has been found that virtually any and all events anywhere in the body affect the knee jerk either to an increase or decrease: inspiration, expiration, clenching a hand, mental arithmetic, somnolence, a sudden loud sound, and so on almost endlessly are such influences. In the present connection, the most significant influence upon the motor centers is, however, chemical: the influence of the blood gases. Thus as Henderson, with the collaboration of Coffey and Barnum,[10] found, a period of forced overbreathing sufficient to induce a slight acapnia (deficiency of carbon dioxide in the blood) and a subsequent brief period of failure of breathing, was followed also, for a slightly longer time, by the abolition of the knee jerk also. Contrariwise rebreathing from a small bag, until enough carbon dioxide had accumulated in the blood to induce a slight increase in the volume of breathing, induced a marked augmentation of the knee jerk. These facts suggest strongly that the blood gases, particularly carbon dioxide, exert an influence upon motor nerve centers that is manifested in muscle tension and the activity of the intramuscular booster pumps essentially as the blood gases are known to influence respiration. In other words, under ordinary normal conditions the amount of carbon dioxide produced in the body determines both the volume of air breathed and the volume of blood circulated. In this way, as Miescher[11] first recognized, the oxygen supply of the body is safeguarded by carbon dioxide.

The other experimental method by which it is possible to test the state of motor centers in their control of muscle tonus has more recently been employed by Henderson and Turner[12] in their study of artificial respiration. They have shown that it is the "elasticity" of the thoracic muscles and diaphragm which makes artificial respiration possible; that this feature of these and other muscles is not a mere mechanical elasticity, but a vital property due to tonus under nervous control; and that in a normal man under artificial respiration it is the blood gases acting upon the respiratory center and its subordinate motor centers that determine the degree of tonic elasticity in the muscles that they innervate. These findings, which are in general accord with those of Hess[13] in experiments on animals, are of particular interest in view of the campaign for the teaching of First Aid by the American Red Cross just now, as this teaching includes the Schafer prone pressure method of artificial respiration. Evidence both in the laboratory and in cases of drowning, electric shock and carbon monoxide asphyxiation indicates that inhalation of a mixture of carbon dioxide and oxygen by increasing the tonic elasticity of the respiratory muscles is a valuable aid to manual artificial respiration in essentially the same way that it increases natural breathing. Both types of evidence show also that such devices as pulmotors, resuscitators, and other suck and blow apparatus are highly unphysiological and may actually do harm. An even greater practical objection to such mechanical devices is that they take time to apply and thereby delay the all important immediate application of artificial respiration. As tonus quickly fails in cases of asphyxia, drowning and electric shock, a delay of a few seconds often causes the loss of a life.

[10] Y. Henderson, *Am. Jour. Physiol.*, 25: 310, 1910.
[11] F. Miescher, *Arch. f. Anat. u. Physiol.* Physiol. Abth., 1885, p. 355.
[12] Y. Henderson and J. McC. Turner, *Jour. Am. Med. Asn.*, 116: 1508, 1941.
[13] W. R. Hess, "Die Regulierung der Atmung." Georg Thieme, Leipzig, 1931.

Peripheral Circulatory Failure and Asphyxia

Whenever, as a consequence of acute illness or physical injury and pain, some of the centers in the nervous system break down and fail in their normal function, one of the accompanying manifestations is a failure also of the circulation. The nervous failure was formerly assumed to be primarily in the vasomotor centers, and to induce a relaxation of the peripheral blood vessels. To that conception the venopressor mechanism now affords an alternative. But no matter whether the primary failure is in the vasomotor control over the arteries and arterioles with pooling in the splanchnic area, as heretofore believed; or whether, instead, the failure is in the spinal motor centers with loss of muscle tonus and slowing of the blood stream in the flaccid muscles, as here presented, the result is the same: a slowing of the blood stream.

Given a progressive slowing of the blood stream leading to peripheral circulatory failure and the first stage of shock, the next problem is that of how the second stage develops from it: that stage consisting in a decrease of blood volume which further diminishes the venous return and the minute-volume of the circulation.

In health the blood stream is so large, or rather so rapid, that in each minute it brings to the tissues a large excess of oxygen; and the excess goes on into the venous blood. When, however, in the development of shock or in the prostration of acute disease, the venopressor mechanism gradually fails, the venous return grows less and less, the circulation progressively slower and slower. Consequently the excess of oxygen brought to the tissues becomes smaller and smaller, until none is left to pass on into the venous blood. The arterial blood is still fully loaded with

oxygen, but as the volume-flow decreases a point is finally reached at which the demands of the tissues are no longer met.[14] Tissue asphyxia then develops, and with it a process analogous to edema. The walls of the capillaries become permeable;[15] and the serum of the blood and some corpuscles ooze out into the tissues. Three interacting results follow: oligemia, bradyrhea,[16] and asphyxia: *i.e.*, decrease of blood volume, slower and slower flow of blood through the tissues and finally anoxia of the tissues.

Such appears to be the causal sequence through which failure of the tonic activity of the motor centers initiates the development of shock. That this sequence is essentially correct is confirmed by the benefit which is now obtained from the intravenous administration of serum. In shock, if accompanied by little or no hemorrhage, the red corpuscles, which are the oxygen carrying portion of the blood, are still in the body, but stagnant, and need only serum to float them. The benefit afforded by mere serum in shock serves to distinguish shock from hemorrhage; for serum alone, even when reinforced by inhalation of oxygen, as it should be, can transport little oxygen. After an exsanguinating hemorrhage, on the contrary, the essential and only means of saving life is restoration of at least some part of the red corpuscles by infusion of whole blood.

Similar in appearance as are the effects of extreme hemorrhage to those of shock from venopressor failure, hemorrhage[17] has an even closer fundamental likeness to carbon monoxide asphyxia, in which the corpuscles are deprived of their capacity to transport oxygen. Yet in their final stages, hemorrhage and shock are as truly forms of asphyxia as is the tissue anoxia induced by carbon monoxide. In all three conditions, the fundamental need is oxygen;[4,18] but the best method of restoring the supply of oxygen in each is different.

Estimation of the Venous Return

Solution of the problems of circulatory failure has been greatly retarded by the lack of a simple method for estimating the volume of the venous return in health and disease. Under just those conditions of failing vitality in which it is most important to follow the decrease or recovery of the venous return, venous pressure is often immeasurably low. It has, however, been found[19] that significant measurements can be made quite easily when the body is inverted at least to such a degree—a slope of 1:4—that all the blood returning from the tissues is—so to speak—poured into the great veins near the heart: the preventricular reservoir of von Recklinghausen. Although this head-down position is not so much of an aid to the circulation as surgeons generally believe, it is of great value for diagnosis. For when one of the patient's arms is then held vertically, or lifted gradually, the top of the column of blood in the veins usually shows a sharply defined meniscus, and the height of that column above some point of reference, such as the symphysis of the clavicles, affords an index of the volume of the venous return. Estimated in this way that volume has been found to be greatly decreased after some major surgical operations and in cases of acute illness. As recovery develops the venous column rises again; as vitality fails, the column sinks progressively lower until it reaches zero as the tonus of the body's musculature disappears at death.

MILITARY GEOLOGY FROM THE AIR

By Professor JOHN L. RICH

UNIVERSITY OF CINCINNATI

THIS paper is written to call attention to the existence of a small body of men competent to perform a new and unique service in the war effort—the interpretation and mapping of geological information of military value revealed on aerial photographs.

The present war, with theaters of activity in regions little known and poorly mapped or entirely unmapped, many of them in enemy hands and inaccessible for study on the ground in advance of occupation, makes it necessary to depend almost entirely on aerial photographs for both topographic and geologic information concerning areas about to be invaded.

Army engineers have developed methods of interpreting the topography and of preparing topographic maps from the photographs, but they can not be expected to be able to read from the pictures the

[14] Y. Henderson, *Am. Jour. Physiol.*, 25: 395, 1910; 27: 152, 1910; Y. Henderson and S. C. Harvey, same journal, 46: 553, 1918; Y. Henderson and T. B. Barringer, Jr., same journal, 31: 289, 352.

[15] E. M. Landis, *Physiol. Rev.*, 14: 404, 1934; C. K. Drinker and J. M. Yoffey, "Lymphatics, Lymph and Lymphatic Tissue," p. 279. Harvard University Press, 1941.

[16] From βραδύς slow and ροία flow. With thanks to my classical colleague, Professor G. L. Hendrickson.

[17] Y. Henderson and H. W. Haggard, *Jour. Am. Med. Asn.*, 78: 697, 1922.

[18] Y. Henderson and H. W. Haggard, "Noxious Gases" (revised edition), Reinhold Publishing Company, 1942.

[19] Y. Henderson and H. W. Haggard, *Jour. Pharmacol.*, 11: 189, 1918.

numerous items of geologic information that may be useful in planning military operations. Among these are the nature of the bedrock—whether hard or soft with all that this implies as to depth of soil, ease of road-building and of all kinds of excavation; whether massive or bedded, and if the latter, whether the beds are horizontal or gently or steeply tilted—features which likewise bear significantly on problems of excavation and ground water supply; whether comparatively undisturbed or badly crushed and broken, and hence difficult to tunnel or mine.

Of equal importance are: features associated with streams such as floodplains liable to inundation, terraces with their well-drained but soft and easily trenched subsoil; deposits of structural materials like sand, gravel or limestone needed for road-building and other construction, which can often be recognized from the air by the trained geologist; and conditions affecting underground water, whether in relation to drinking water supplies or to drainage.

These are only a few of the numerous geological features of military significance which the men of whom I am writing should be able to recognize and interpret from the aerial photographs.

The men competent to perform such services are geologists who combine in their training and experience all the following essentials: (a) Thorough training in geomorphology, the science of land forms, which enables them to recognize by their topographic expression a wide variety of geologic structures and of earth materials. (b) A broad and varied field experience, for it is only through such experience that a geologist gains the high degree of competency necessary for the interpretation of the multiplicity of features likely to be encountered in our present and future theaters of war activity. (c) Experience in actually seeing and interpreting from the air the greatest possible variety of geologic features, and finally, (d) experience in the actual interpretation of aerial photographs and comparison of the appearance of various geological features in the photographs with their appearance on the ground. For this aspect of the geologist's preparation, actual experience in using aerial photographs in the field as base maps for geologic mapping is particularly valuable.

The reason why a geologist with the training and experience outlined above can read so much of the geologic story in aerial photographs, even though they may have been taken in wooded country, is inherent in the fundamentals of the science of earth forms with which the geologist is familiar. He knows what kinds of forms are produced by streams, wind, glaciers or landsliding and how to recognize (within limits) the various kinds of bedrock such as granite, shale, limestone or lava by the distinctive forms into which they are carved by erosion. He is familiar with the differential etching of the earth's surface by weathering and erosion, whereby areas underlain by weak rock are lowered while those underlain by resistant rock stand out in relief, and he is expert in interpreting the structure or "lay" of the rocks by the relief features so produced.

Because the kinds of rock and their structures are thus revealed through the way in which they are affected by the agencies of erosion, the experienced geologist with the training outlined above is able, from photographs alone, to supply a large amount of militarily useful information about an unknown region in advance of its occupation by ground forces. No one but the geologist so trained is in position to do this, because the experience and background training involved can neither of them be acquired in a short space of time. Experience is more or less proportional to the time the geologist has spent in actual field work on the ground and in reconnaissance from the air and study of aerial photographs directed specifically toward the recognition of various types of terrain.

Comparatively few of the geologists of the United States are now competent to do this because comparatively few have had all the required elements of training and experience listed above. Yet those few may be able to render service of inestimable value if stationed at regional staff headquarters. A larger number, lacking perhaps only experience in interpretation of photographs, or in viewing the ground from the air, could however become reasonably competent after a few weeks or months of special training.

The training that most geologists have had, even though through lack of experience they may not be qualified for the work outlined above, tends to make them more than ordinarily competent to carry on the more general types of work in connection with the interpretation of aerial photographs.

Considered broadly, there appear to be four aspects of the interpretation of such photographs: (1) The interpretation of cultural and military features, such as roads, trails, gun emplacements, tracks and trails made by troops, artillery convoys, and so forth. (2) The interpretation of relief. (3) The use of aerial photographs for map construction, and finally (4) the interpretation from the photographs of geologic features as outlined above. Considering each of these aspects in turn:

(1) As to the location of ordinary cultural and military features, men trained in geology probably can not do much more than other reasonably keen and intelligent persons (especially those with some previous military training) will be able to do after a certain amount of practice in the interpretation of

photographs, except that the geologists are much more likely to be able to recognize camouflage as not being in harmony with the natural landscape.

(2) As to relief *per se,* the man with geological training probably will have a decided advantage in recognizing relief features on non-stereoscopic pictures because he will have a comprehension of relief as a systematic topographic expression associated with drainage lines or rock structures, and therefore may be able to infer from drainage lines and vegetation patterns relief features which would not be evident to the untrained observer. Even with stereoscopic pictures the fact that the features automatically fall into logical and therefore easily remembered patterns gives the geologist a distinct advantage.

(3) As to the methods of construction of maps from aerial photographs, geologists in general are not in position to contribute anything not already known and practiced by the Army Engineers. As actual workmen, however, engaged in map-making from the photographs, geologically trained men should have a distinct advantage over others because they are in the habit of using maps and even of making maps of both topographic and geologic features, and consequently should be in position to do effective work much more quickly than men without such training.

As to (4), the interpretation of terrain, that, as I have tried to make clear above, is a field for the few highly trained specialists. It is a field so new that its possibilities are not likely to have been fully realized by army commanders or even by geologists themselves.

In view of the world-wide nature of the present conflict and of the comparatively unknown character of much of the territory over which operations must be conducted, a technique such as the geological interpretation of aerial photographs of areas that can not be examined on the ground promises to yield information of the greatest importance that can not be obtained in any other way.

OBITUARY

C. HART MERRIAM

DR. C. HART MERRIAM, one of the stalwarts of the scientific world, died on March 19 at the age of 86, in Berkeley, Calif. Physician, naturalist, ethnologist, explorer, scholar, lecturer, author, personal friend of Presidents—he was a prominent figure of two generations.

From early boyhood in the Adirondack region of New York, his dominant interests were in the field of natural history. Beginning about 1867 with insects and birds, his activities soon expanded to cover mammals and reptiles, then marine invertebrates and plants. When only 16 (in 1872) he was appointed by Professor Spencer F. Baird, assistant secretary of the Smithsonian Institution, as naturalist of the Government Survey of the Territories (known as the Hayden Survey) and he made extensive collections in Utah, Idaho and Wyoming. In 1875, while a student at Yale, he was summer assistant on the U. S. Fish Commission at Woods Hole, Mass. Following graduation from the College of Physicians and Surgeons, Columbia University, in 1879, he practiced medicine and surgery in northern New York. In 1883, as surgeon of the *SS Proteus* he visited the Newfoundland seal fisheries on the ice floes between Labrador and Greenland.

In 1891 President Harrison appointed Dr. Merriam as Fur Seal Commissioner to represent the United States on a joint American and British commission to study the problems of pelagic sealing on the Pribilof Islands. In 1899 he again visited Alaska and the Bering Sea, on the Harriman Alaska Expedition, whose scientific personnel he selected.

While studying in the museums of England, Holland and Germany, in 1885, he was recalled to organize a division of ornithology in the Department of Agriculture, and soon converted it into the U. S. Biological Survey, of which he was chief for twenty-five years. During this epochal period of investigation, in which he played so important a part, he made field studies or led biological explorations (mainly by pack-horse outfits and most frequently accompanied by Vernon Bailey, long chief naturalist of the Biological Survey) in every state and also in Bermuda, Canada and Alaska. Among the more important of these surveys in the Far West were those of San Francisco Mountain, Arizona, including the Painted Desert and a section of the Grand Canyon; the Death Valley region and neighboring deserts in California, Nevada and Utah; the Snake Plains and adjacent mountains in Idaho, and Mount Shasta in northern California.

In addition to their many other scientific values, these and other explorations were proving grounds for Dr. Merriam's development of the laws of temperature control of the geographic distribution of animals and plants in North America. His life-zone concepts have been widely accepted by the scientific world.

He was a member of the U. S. Board on Geographical Names for twenty years and chairman for eight years. Two natural landmarks bear his name: Mount Merriam in California, amongst the group of High Sierra peaks that have been named for eminent scien-

tists, and Merriam Crater in northern Arizona. He was the last of the original founders of the National Geographic Society, on whose board of directors he served continuously for 54 years.

In 1910 Dr. Merriam resigned from the Biological Survey to continue natural-history and ethnological investigations under a special fund established in the Smithsonian Institution by Mrs. E. H. Harriman. Since that date he has devoted the major portion of his time to ethnological studies of the native Indian tribes of the Far West and to the betterment of their condition. He was an authority on distribution, languages, mythology and basketry of the tribes of California and Nevada. His original data are preserved in vocabularies, manuscripts, boundary maps and a collection of approximately 1,100 baskets representing 157 separate tribes of 25 linguistic stocks—including a number of California tribes now extinct.

Dr. Merriam is credited with having named and described about 700 different genera, species and subspecies of animals; in addition, numerous other species have been named for him.

Further evidence of his boundless enthusiasm, tireless energy and breadth of interests is furnished by his set of journals spanning a period of about 70 years, and by the extent of his published writings numbering upwards of 500 titles plus numerous book reviews. The wide range in subject matter is illustrated by a few examples: The Birds of Connecticut (1877); Mammals of the Adirondacks (1884); Life Zones and Crop Zones of the United States (1898); Biological Survey of Mount Shasta (1899); Dawn of the World (Mewan Indian myths, 1910); Review of the Grizzly and Big Brown Bears of America (1917); Earliest Crossing of the Deserts of Utah and Nevada to Southern California—Route of Jedediah S. Smith in 1826 (1923), and Classification and Distribution of the Pit River Indian Tribes of California. (1926).

When SCIENCE was reorganized in 1894 Dr. Merriam was a member of the editorial committee and continued to hold this position until his death after forty-seven years.

Dr. Merriam was a member of the National Academy of Sciences (since 1902), the Zoological Society of London and many other scientific societies. He was a past president of the American Ornithological Union, the American Society of Naturalists, the American Society of Mammalogists, the Anthropological Society of Washington, the Biological Society of Washington, the Linnaean Society of New York, the Yale Society of Natural History, and the Lewis County (N. Y) Medical Society. He enjoyed honorary membership in numerous foreign as well as American organizations.

He was the recipient of outstanding awards, including the Linnaean Society's Medal "for eminent work in mammalogy, ornithology and zoogeography" and the Roosevelt Medal "for distinguished work in biology."

His contagious enthusiasms were an inspiration to his colleagues, especially the younger naturalists. Along with his intense interest and driving energy in things scientific, he loved people. He was never too busy to help his friends in all walks of life, among whom he numbered hundreds of California Indians. The wide diversity of his friends and interests is further reflected by his intimate friendship with such people as Theodore Roosevelt, John Burroughs, John Muir, William Keith, Governor Pinchot, E. H. Harriman, General Funston, Samuel Pierpont Langley, Alexander Graham Bell, Gilbert Grosvenor, Admiral Peary, General Greeley, Rudyard Kipling, Sir Baden Powell, William Wallace Campbell and David Starr Jordan.

Dr. Merriam lived in Washington, D. C., during the winter for the greater part of his long and eventful life. His summer home was in the redwoods at Lagunitas, Calif., until 1939, when he made his home with his daughter in Berkeley.

Z. M. TALBOT
M. W. TALBOT
BERKELEY, CALIF.

RECENT DEATHS

FRANK COLLINS BAKER, curator emeritus of the Museum of Natural History of the University of Illinois, died on May 7, at the age of seventy-four years.

DR. CHARLES ROLLIN KEYES, consulting mining engineer, founder and editor of the *Pan-American Geologist Magazine,* died on May 18, at the age of seventy-seven years.

DR. WINFIELD CAREY SWEET, field director of the anti-malaria division of the Rockefeller Foundation in Bolivia, died on May 19, at the age of fifty years.

DR. MARCUS WARD LYON, JR., pathologist of the Clinic, South Bend, Ind., died on May 19, at the age of sixty-seven years.

Nature reports the death of Dr. B. M. Griffiths, formerly reader in botany and head of the department of botany in the University of Durham, on March 25, aged fifty-five years; of H. J. Hughes, formerly principal of the Muresk Agricultural College, Western Australia, on September 27, aged sixty-seven years; of F. J. Rae, director of the Melbourne Botanic Gardens and Government botanist for Victoria, on September 18; and of L. Wray, formerly director of the State Museums, Malaya, on March 14, aged eighty-nine years.

SCIENTIFIC EVENTS

THE POLISH INSTITUTE OF ARTS AND SCIENCES

IT is reported in *The New York Times* that there has been established in New York City, with headquarters at 37 East 36th Street, a "Polish Institute of Arts and Sciences in America," composed of members of the original Polish Academy of Arts and Sciences who are now in this country. The official opening of the institute, which has been formed to "insure continuity of Polish cultural life which the Nazis seek to exterminate," took place on May 15. Professor B. Malinowski, of Yale University,[1] represented the new board of the institute. Professor O. Halecki, formerly dean of the Faculty of Arts in the University of Warsaw and now a visiting professor of history at Vassar College, has been named director of the institute. Professor R. Taubenschlag, formerly dean of the Faculty of Law in the University of Cracow, now associate professor in the New School for Social Research, will be the associate director. After the war the institute will be taken over by the Polish academy as a permanent institution promoting intellectual cooperation between America and Poland.

The audience, numbering about two hundred, was addressed by Jan Ciechanowski, Polish Ambassador to the United States. Others who spoke were Dr. W. G. Leland, director of the American Council of Learned Societies and president of the International Union of Academies; Professor Halvden Koht, formerly Norwegian Minister of Foreign Affairs; Paul Super, formerly director of the American YMCA in Poland; Professor Oscar Halecki, director, and Professor Raphael Taubenschlag, associate director.

Congratulatory messages were received from leaders of the Polish Government in exile, including President Wladyslew Raczkiewicz and Premier Wladyslaw Sikorski.

THE COLLEGE OF ENGINEERING OF NEW YORK UNIVERSITY

NEW YORK UNIVERSITY, in cooperation with Adelphi College, has established a Day Division of its College of Engineering on the Garden City campus of Adelphi, and will open freshman classes for men and women on June 29.

The evening division of the College of Engineering, which was established at Adelphi in February, will be continued. The opening of the day division marks the inauguration of fully accredited engineering study for day students on Long Island, and under the plan of operation it will be the first coeducational engineering program in metropolitan New York.

The engineering classes will be conducted on the "war speed-up plan" already adopted by many engineering schools throughout the nation. Classes will begin on June 29 and run through the summer and fall terms of 1942, and through the spring and summer of 1943. After this period of 14 months, students will have completed the first two years of engineering study, and will be qualified to continue study as third-year students. At the same time, however, the 14 months of study will qualify students for many sub-professional positions with war industries, for civil service positions and for advanced study in other scientific fields. In a statement made by Dean Thorndike Saville this two-year "terminal" feature of the program has been introduced in recognition of the changing demands being made upon education.

The urgent need for engineering specialists commissioned in the military services and for technically trained personnel in our war industries makes it desirable that in carrying out the vitally important task of educating more professional engineers, we do not overlook the value of the first two years of engineering as a means of training sub-professional engineering personnel for both war and peacetime service with industry.

The administrators of both Adelphi College and New York University recognize both these national needs and hope to pioneer the field in meeting it with the establishment of the day division at Garden City, together with the operation of the evening division in engineering.

The plan provides that students will conclude their degree training at the University Heights center of the university, where junior and senior year instruction will be given, following the work at Garden City.

The need for highly specialized engineering laboratory study in the last two years makes it impossible to conduct these courses at Garden City. At University Heights the College of Engineering maintains five buildings devoted to technological and scientific laboratories, wind-tunnels, observatories, and administrative, aeronautical, chemical, civil, electrical, mechanical engineering and meteorology. The duplication of such facilities on Long Island would be impossible at this time.

THE ANNUAL REPORT OF THE BROOKLYN BOTANIC GARDEN

IN the thirty-first annual report of the Brooklyn Botanic Garden, which has just appeared, the director, Dr. C. Stuart Gager, calls attention to the fact that the garden is within ten minutes' walk, or less, of the geographic center of Brooklyn. This accounts, in part, for the attendance, in 1941, of more than 1,753,000 persons. This large attendance, it is pointed out, is doubtless also due to the fact that each year the grounds become more and more beautiful. The attendance of classes from the schools of all boroughs was

[1] Dr. Malinowski died on May 16.

more than 116,000—the largest in the history of the garden.

The services which the garden renders to the city are many and varied. During 1941, more than 1,050,000 packets of seeds were distributed to school children for planting in school and home gardens, and the amount of vegetables raised in the "Children's Garden," a special area of about three quarters of an acre, is impressive. Each year, for the past three years, the crop there has included, for example, more than a ton of tomatoes. The "Children's Garden" is, however, conducted primarily as an educational activity, the crop of vegetables and flowers being considered of secondary importance.

The Brooklyn Garden administers one of the largest programs of public education of any botanic garden in the world. The entire staff of experts functions as a bureau of free public information and the number of requests for information increases yearly in number and variety.

The work of the garden falls under two heads, the increase of our knowledge of plant life—especially the practical knowledge of plant diseases and plant breeding and the dissemination of technical and popular information to the general public. A library of more than 40,000 volumes and pamphlets on all aspects of plant life is open daily to the public.

Of an operating budget for 1941 of $182,266, the city provided 51 per cent., and the trustees of the institute provided for the remainder out of private funds. During six of the past eight years the trustees have provided more than half the cost of maintenance and development.

The director calls attention to the urgent need of a suitable gate at the main entrance on Eastern Parkway and also to the need of an addition to the laboratory building to accommodate the rapidly expanding activities and the increasing collections of the library and herbarium and to provide for continually increasing educational demands.

THE NUTRITION FOUNDATION

DR. KARL T. COMPTON, president of the Massachusetts Institute of Technology, chairman of the Board of Trustees of the Nutrition Foundation, announced on May 20 that the foundation had awarded grants of $125,000 for fundamental research in the science of nutrition.

George A. Sloan, president of the foundation, reported the election of the National Dairy Products Corporation as a founder member and the election of its president, L. A. Van Bomel, as a member of the board of trustees. Dr. Lloyd K. Riggs, of National Dairy Products, and Dr. J. T. Knowles, in charge of the Chicago Laboratory of Libby, McNeill and Libby, were appointed members of the food industries advisory committee.

Dr. Compton said that the board had considered a large group of applications with reference to three primary objectives, which the board wishes particularly to support under present conditions: (1) their contribution to our war effort; (2) their immediate advantage to public health; (3) their long-time advancement of the fundamental science of nutrition—the kind of exploratory research that will lay the foundation for better health and scientific guidance in the food industry of to-morrow. The grants were recommended to the board of trustees by Dr. Charles Glen King, scientific director, after appraisal by the scientific advisory committee of the foundation.

The companies whose contributions as founder members are making this program possible include, to date: American Can Company, Beech-Nut Packing Company, California Packing Company, Campbell Soup Company, The Coca-Cola Company, Continental Can Company, Inc., Corn Products Refining Company, General Foods Corporation, H. J. Heinz Company, Libby, McNeill and Libby, National Biscuit Company, National Dairy Products Corporation, Owens-Illinois Glass Company, The Quaker Oats Company, Standard Brands, Inc., Swift and Company and the United Fruit Company.

Dr. F. G. Boudreau, of the Milbank Memorial Fund, in addressing the members of the board of trustees, said:

> Progress in the science of nutrition has far outrun its application for the benefit of society. Much more has been done for animals than for human beings. Scientific feeding of live stock has paid high dividends. Scientific feeding of human beings would pay big dividends of a different kind. If all that we know about nutrition were applied to modern society, the result would be enormous improvement in public health, at least equal to that which resulted when the germ-theory of infectious disease was made the basis of public health and medical work.

THE AMERICAN PHYTOPATHOLOGICAL SOCIETY

THE summer meeting of the American Phytopathological Society will be held on June 25 and 26 at the Secor Hotel, Toledo, Ohio. Dr. H. C. Young, chief of the department of botany and plant pathology of the Ohio Agricultural Experiment Station at Wooster, is chairman of the "program and arrangements" committee for the meeting.

The program will be based largely on the activities of the War Emergency Committee of the American Phytopathological Society. The meeting will open at 10 A.M., on June 25, with reports and discussions on "The Role of Plant Pathologists in the War Pro-

gram." Dr. E. C. Stakman, chief of the department of plant pathology and botany of the University of Minnesota and chairman of the war emergency committee of the society, will preside.

Dr. J. S. Horsfall will lead a round-table discussion on spray material and spray equipment priorities and substitute materials. Following this there will be a demonstration of techniques used in determining physical properties of dust mixtures and performance of dusting equipment.

The second day of the meeting, June 26, will include a discussion on the policies of plant pathology extension, research and teaching during the present emergency.

The final session on the afternoon of June 26 will deal with a summary of the program, policies and future activities of the society's war emergency committee.

AWARD OF THE PRIZE IN PURE CHEMISTRY OF THE AMERICAN CHEMICAL SOCIETY

THE prize of $1,000 in pure chemistry of the American Chemical Society has been awarded for 1942 to Dr. John Lawrence Oncley, associate in physical chemistry at the Harvard Medical School and instructor in chemistry at the Massachusetts Institute of Technology. Presentation of the award, given annually for "outstanding research in pure chemistry by a man or woman less than thirty-six years old," will take place at the one-hundred-fourth meeting of the society in Buffalo, N. Y., from September 7 to 11.

Dr. Oncley, who also is an instructor in chemistry at the Massachusetts Institute of Technology, was chosen in recognition of his contributions in the field of protein chemistry, in recognition of his investigations in the dielectric properties of gases, insulating oils, resins, rubbers and proteins and "for the development of radio-frequency bridge methods suitable for precise dielectric constant determinations with proteins." With the aid of these methods, it was said, he has completed the first entirely satisfactory study of the dielectric dispersion behavior of water-soluble proteins. "This work," according to the citation, "constitutes one of the really significant contributions of recent years to protein chemistry. These studies in turn have led to an interest in the molecular size and shape of protein molecules."

The American Chemical Society Prize, sponsored this year by Alpha Chi Sigma, national scientific fraternity, was founded in 1931 by the late A. C. Langmuir to encourage fundamental research by young chemists working in North America. Dr. Everett S. Wallis, of Princeton University, was chairman of the committee of award. Other members were Dr. George Scatchard, of the Massachusetts Institute of Technology, and Dr. Ralph L. Shriner, of Indiana University.

SCIENTIFIC NOTES AND NEWS

DR. FREDERICK P. KEPPEL, from 1923 to 1941 president of the Carnegie Corporation of New York, received from the American Association of Museums, at its annual meeting in Williamsburg on May 19, its award "for distinguished service rendered to the cause of museum education." This award, established in 1940 by Henry W. Kent, a former secretary of the Metropolitan Museum of Art, takes the form of a diploma. The presentation was made by Dr. Clark Wissler, of the American Museum of Natural History, president of the association.

AT the annual banquet of the Virginia chapter of Sigma Xi, held at Farmington on May 4, Dr. Walton C. Gregory, assistant professor of biology, Tennessee Polytechnic Institute, formerly a research fellow of the Blandy Experimental Farm, University of Virginia, was awarded the President and Visitors Research Prize in the natural sciences for his paper, entitled "Phylogenetic and Cytological Studies in the Ranunculaceae."

FRANKLIN AND MARSHALL COLLEGE, on the occasion of the installation as president on May 16 of Dr. Theodore A. Distler, formerly dean of Lafayette College, conferred the degree of doctor of science on Dr. Clarence E. McClung, professor emeritus of zoology of the University of Pennsylvania, and on Dr. William Henry Welker, head of the department of physical chemistry at the University of Illinois.

THE honorary doctorate of science was conferred on May 24 at the commencement exercises of the University of South Dakota on Dr. John H. Lawrence, '26, of the University of California, for "successful therapeutic use of radioactive phosphorus to produce remissions in leukemia in man and for his development of the medical applications of neutrons and artificially radioactive elements"; and on Lieutenant-Colonel Harry G. Armstrong, '28, in recognition of his work in the field of aviation medicine.

PURDUE UNIVERSITY conferred the honorary degree of doctor of agriculture, at the commencement exercises on May 3, on J. Clyde Marquis, adviser of the Office for Foreign Relations of the Bureau of Agricultural Economics, U. S. Department of Agriculture.

AT the spring congregation of the University of

British Columbia held on May 14, the honorary degree of doctor of laws was conferred upon Dr. C. McLean Fraser, professor emeritus of zoology. Dr. Fraser was head of the department of zoology for more than twenty years.

IN appreciation of his twenty-five years of service to the Ohio State University and on the occasion of his impending retirement as chairman of the department of zoology and entomology, the friends and associates of Dr. Raymond C. Osburn tendered him a testimonial dinner on the evening of May 11. A bound volume of letters from present and former students and colleagues was presented to him.

THE recipient this year of the Henry Russel Award of the University of Michigan is Dr. Richard H. Freyberg, assistant professor of medicine and director of the Rackham Arthritis Research Unit. The award, made in recognition of "distinguished achievement in medical research," is conferred annually by the university on a member of the faculty below the rank of associate professor.

PROFESSOR HARRY B. WALKER, head of the agricultural engineering division of the College of Agriculture at Davis of the University of California, has been elected president of the American Society of Agricultural Engineers. The annual meeting of the society will be held in Milwaukee from June 29 to July 1.

MEMBERS of the faculty of the University of California who will retire this year include Dr. William H. Wright, professor of astronomy and director of the Lick Observatory; Dr. Robert T. Legge, professor of hygiene; Dr. Robert E. Keys, associate professor of denture prosthesis; Dr. Frank W. Lynch, professor of obstetrics and gynecology; Dr. Howard L. Howard, professor of pomology, and Professor John W. Gilmore, professor of agronomy.

DR. ROBERT F. LOEB, since 1921 a member of the School of Medicine of Columbia University, has been appointed to the Lambert professorship of medicine. The chair was established this spring by the Columbia Board of Trustees in honor of the late Dr. Samuel Waldron Lambert, dean of the School of Medicine from 1904 to 1919. Dr. Lambert died on February 9.

PROFESSOR HAROLD W. BIBBER, of the department of electrical engineering at the Ohio State University, has been named professor of electrical engineering and administrative head of all engineering divisions at Union College, Schenectady, N. Y.

DR. M. DON CLAWSON has been appointed director of dental education at Meharry Medical College, Nashville, Tenn. The establishment of this position has been made possible by a grant from the Kellogg Foundation.

NEWLY elected officers of the Sigma Xi Chapter of the Ohio State University are: Professor John B. Brown, physiological chemistry, *President;* Professor Dwight M. DeLong, zoology and entomology, *Vice-president;* Professor Alfred B. Garrett, chemistry, *Secretary-Treasurer;* Professor Jorgen M. Birkeland, bacteriology, and Professor Lincoln LaPaz, mathematics, *Board of Electors.*

ROBERT M. SALTER, head of the Division of Soil and Fertilizer Investigations of the U. S. Department of Agriculture, has been appointed chief of the Bureau of Plant Industry, succeeding Dr. E. C. Auchter, who was recently appointed administrator of the Agricultural Research Administration. Dr. R. O. E. Davis, of the Bureau of Chemistry and Soils, has been designated acting head of the Division of Soil and Fertilizer Investigations.

THE American Ornithologists Union has elected John T. Zimmer, executive curator of birds of the American Museum of Natural History, to the post of editor of *The Auk,* the official organ of the society. He takes the place of Dr. Glover M. Allen, who died on February 14. Manuscripts intended for publication and books and papers intended for review should now be addressed to Mr. Zimmer at the American Museum of Natural History.

RUDYERD BOULTON, curator of birds at Field Museum, Chicago, has been granted indefinite leave of absence to accept an appointment to the staff of the Coordinator of Information at Washington.

DR. W. EDWARDS DEMING, formerly mathematical physicist with the Department of Agriculture and since 1939 mathematical adviser in the Bureau of the Census in charge of sampling designs, has recently been detailed for six months to the Inspection of Army Ordnance, in the capacity of adviser in sampling. At the end of the period he will return to the Bureau of the Census.

BRIGADIER-GENERAL ROBERT H. MILLS, U. S. Army, has recently been appointed chief of the Dental Corps. He occupies the position made vacant by the retirement of Brigadier-General Leigh Fairbank.

THE application by the council of the Zoological Society, London, to the Privy Council for leave to suspend temporarily the post of secretary—now held by Dr. Julian Huxley—has been declared invalid. The decision, which reverses a previous decision by the Privy Council, follows efforts by an informal committee of fellows of the society in challenging the council's action. Dr. Huxley has offered to serve as

secretary "on leave" and without pay. Lord Horder has been nominated as president of the society in the place of Lord Onslow.

DR. MICHAEL HEIDELBERGER, of the College of Physicians and Surgeons, Columbia University, gave on May 8 and 9 at the University of Wisconsin, under the auspices of the Wisconsin Alumni Research Foundation, lectures on "Modern Concepts of Immunity and the Part of Chemistry in Their Development."

THE U. S. Civil Service Commission announces that the closing date for the receipt of applications for the position of junior chemist will be June 1. The commission will continue to receive applications from women for these positions until the needs of the service have been met. All applications must be filed with the Washington office. Complete information is contained in the original announcement.

ACCORDING to the *Journal* of the American Medical Association the W. K. Kellogg Foundation has offered to each one of nearly a hundred and fifty schools of medicine, dentistry, public health and nursing in the United States and Canada funds to be used for loans to students and scholarships. The foundation leaves the matter of scholarships in the hands of the school. It is planned to set up loan funds so that payments on loans will be made to the schools and thus provide a continuing or revolving fund. The scholarships will be granted on the basis of the scholastic ability, character and need of the applicant in comparison with other applicants. The only restriction suggested is that it should not be more than $500 to any one student in any one year.

THE sixty-eighth annual meeting of the American Neurological Association will be held at the Drake Hotel, Chicago, on June 4, 5 and 6, under the presidency of Dr. Lewis J. Pollock, Chicago.

THE American Society of Clinical Pathologists will hold its twenty-first annual meeting and its ninth seminar at the Hotel Benjamin Franklin, Philadelphia, from June 4 to 7, under the presidency of Dr. John L. Lattimore, of Topeka, Kans. His address will be entitled "The Pathologist as a Physician."

SPECTROSCOPY, of which the practical applications have become important for the war effort, will be the subject of a four-day conference that will be held at the University of Chicago from June 22 to 25. Subjects ranging from the spectra of comets to the molecules in synthetic rubber will be discussed in twelve sections. Of special interest during the present curtailment of dyes is the symposium to be held on June 24 on the spectra of dye molecules, in which will be reported the latest developments in dyemaking. Those who will take part in the conference include James Frank, Nobel laureate, professor of physical chemistry at the University of Chicago; W. F. Meggers, the National Bureau of Standards; A. McKellar, Dominion Observatory, Victoria, British Columbia; W. E. Williams, the University of London; F. L. Whipple, Harvard Observatory, and P. Pringsheim, the University of Chicago.

A CHAPTER of the Society of the Sigma Xi was established at the Illinois Institute of Technology on March 25. The national president, Dr. R. A. Gortner, and the national secretary, Dr. G. A. Baitsell, took part in the ceremonies, attended by eighty local members and delegates from seven other colleges and universities. Dr. Rufus Oldenburger, associate professor of mathematics; Dr. David Boder, professor of psychology; Dr. George Ziegler, physicist, and Dr. Hugh McDonald were elected *President, Vice-president, Secretary* and *Treasurer,* respectively. Dr. H. A. Bethe, of Cornell University, delivered an address entitled "Energy Production in Stars." At a subsequent meeting eleven members and sixteen associates were elected to the local chapter, the following professors being among those elected to membership: Dr. Hans Reissner, Dr. Vasili Komarewsky, Dr. Michael Sadowsky and Dr. Myril Reed.

IT is reported that the War Department is planning to take over on August 1 the Battle Creek Sanitarium for use as a general base hospital. Its estimated value is $12,000,000. Dr. John Harvey Kellogg, who was medical director of the sanitarium for many years, is now a member of the board entrusted with control in the reorganization of 1938, after financial difficulties. The Army, it is said, will assume payment of a $1,271,500 mortgage, $18,300 in unpaid taxes and other liens, amounting in all to $2,250,000.

DISCUSSION

THE GEOLOGICAL HISTORY OF THE BERMUDAS

THE Bermudas being oceanic islands, any evidence as to their geological history is of considerable value. It is known from a single deep boring[1] and from two seismic soundings[2] that there is a volcanic core now lying at a depth of about 250 feet below sea level. Sayles[3] considers that this was cut down to its present

[1] L. V. Pirsson, *Am. Jour. Sci.,* 38: 189–206, 331–334, 1914.

[2] G. P. Woolard and M. Ewing, *Nature,* 143: 898, May 27, 1939.

[3] R. W. Sayles, *Proc. Am. Acad.,* 66: 11, 380–467, 1931.

level by wave action during tertiary times and not during the period of much lower sea level of pleistocene times. Finally from the evidence of submerged caves (Sayles, *loc. cit.*) and from peat bogs[4] it is clear that sea level in Bermuda must at one time have stood at least 60 to 100 feet lower than at present, and possibly considerably more, while from raised beaches (Sayles, *loc. cit.*) it appears to have stood at one time at least 25 feet higher than at present.

Practically all the rocks now above sea level in Bermuda are eolianites formed, together with alternating soil layers, during the glacial and interglacial periods. There is a small amount of marine limestone which, from its coarse particle size and the nature of its fossils, seems to have been consolidated from either beach sand or a very shallow water deposit.

During dredging operations for the new American air base at Bermuda, large amounts of rock have been brought up from 30 to 50 feet below sea level in Castle Harbor. These appear to fall into the following categories: deepest of all is a reddish-brown clay, quite unlike anything previously known from Bermuda, and Dr. E. S. Larsen, who has examined it, states that it probably was derived from the weathering of volcanic rocks. It contains no fossils except foraminifera, and from its very fine texture would seem to have been deposited in fairly deep water, probably after reworking. Above this is calcareous rock, also of extremely fine texture, and characterized by the very abundant coral *Cladocera arbuscula* Le Seur, many other fossils also being present. Above this again is a rock of similar fine texture but characterized by the coral *Occulina*, which, while abundant in shallow water, extends deeper than most of the typical reef corals. Reef corals such as *Meandra, Montastraea, Porites* and *Siderastrea* are rare or absent in these two rocks.

Above these fine texture rocks is a much coarser calcareous sandstone such as might be formed from the deposits in the shallow areas inside the present reefs, and containing most of the modern reef corals, but not *Cladocera*. Finally above these is unconsolidated sand, whose fauna resembles in most respects that of the present day. With the exception of small local patches of peat, which indicate temporary mangrove swamp conditions, the scarcity of purely littoral species is striking.

The above is a summary of the observations which we have made to date, and which it is hoped will be considerably expanded when Dr. Frederick Foreman, who is working on the minerals from these formations, completes his investigations. The sequence of rocks and their fauna suggests a progression from fairly deep to shallow water conditions. As this range of probably several hundred feet is represented by only 30 to 50 feet of deposits, the change was presumably due to either a rise of the land or a drop in sea level. Since these deposits, except for the recent loose sand, are all below the land eolianites, they are presumably preglacial. Also, in glacial times the sea level was lower, and not higher than at present. According to Daly[5] in late Tertiary times sea level was probably 85 to 170 feet higher than it is now, and this would be quite sufficient to account for the observed sequence of fauna in the rocks.

HILARY B. MOORE

BIOLOGICAL STATION,
BERMUDA

[4] A. S. Knox, *Jour. Geol.*, 48: 7, 767–780, 1940.

[5] R. A. Daly, *Bull. Geol. Soc. Amer.*, 40: 721–734, 1929.

A GROUND SLOTH IN ALASKA[1]

CHILDS FRICK, honorary curator of the American Museum of Natural History, has kindly permitted me to examine and report upon a phalangeal element of an extinct megalonychid ground sloth from the Quaternary of Alaska. The specimen, No. F.A.M. 30844, a first or proximal phalanx, possibly of the fourth digit, manus, is larger than the corresponding bone in *Nothrotherium* and represents apparently a species of *Megalonyx*. Curiously enough, it is the only ground sloth material thus far recorded from the frozen muck of Alaska. This is all the more remarkable in view of the fact that during thirteen seasons of work since 1929 the Childs Frick Expeditions in cooperation with the University of Alaska have conducted intensive paleontological explorations in this northern region. The present specimen, found by Otto Wm. Geist during the field season of 1941, adds another large mammal to the extinct pre-tundra fauna known from Alaska.

The site of discovery of the *Megalonyx* phalanx occurs on Cripple Creek, approximately fifteen miles southwest of Fairbanks. Associated fossil mammals from this region[2] include the woolly mammoth (*Mammonteus primigenius*), mastodon (*Mammut americanum*), horse (*Equus alaskae*), bison (*Bison crassicornis*), ovibovids (*Symbos tyrrelli* and *Boötherium sargenti*), camel (*Camelops*), saiga antelope (*Saiga ricei*), as well as large carnivores like the great cat (*Panthera atrox*), short-face bear (*Arctotherium yukonensis*) and dire wolf (*Aenocyon dirus*).

The genus *Megalonyx* is associated with the Pleistocene forest faunas of the more southerly regions of North America. Remains of this mammal were first described by Thomas Jefferson from a limestone cave in western Virginia. Since then these ground sloths have been encountered at a number of Pleistocene localities in North America from southern Nuevo

[1] Contribution No. 335, California Institute of Technology.

[2] C. Frick, *Nat. Hist.*, 30: 69–80, 1930. Illustrated.

Leon, Mexico, to eastern Washington. The occurrence in Alaska extends the geographic range of *Megalonyx* considerably to the north of its previously known distribution.

CHESTER STOCK

A VESTIGE OF BABYLONIAN INFLUENCE IN THERMOMETRY

IT is well known that our common measures of time and angles—in terms of degrees, hours, minutes and seconds—are derived from the ancient Sumerians of the Mesopotamian valley who made use of a sexagesimal system of numeration. It is less manifest, but nevertheless also true, that the common measure of temperature in terms of degrees Fahrenheit is likewise a product of Sumerian or Babylonian influence.

Galileo's application of the telescope to astronomical observation had an immediate and profound effect on science. On the other hand, his invention of the thermometer apparently failed at first to impress either Galileo himself or his successors in science. This fact undoubtedly is to be ascribed to the lack at that time of a standard and universally reproducible scale. The Florentine academicians and their associates subdivided the interval between the extreme cold of winter and the greatest heat of summer into an arbitrary number of equal parts—sometimes fifty; or again one or more hundreds; or occasionally 360, to correspond to the Babylonian "degree" measure of the circle. Such thermometric scales competed during the seventeenth century with others, notably those based on the medieval division into eight degrees of heat and cold. During this period there was no one scale which conventionally was preferred either as to fixed points or as to subdivisions.

Very early in the eighteenth century Roemer carried out investigations in thermometry in which he chose the boiling point of water as his higher fiducial point and the temperature of a mixture of ice and salt as the point of extreme cold. It then remained for him to subdivide the interval between these points in some suitable manner. Numerous suggestions already had been made by others, but Roemer's choice in all probability was determined by the fact that he was interested primarily in astronomy. In this field Babylonian tradition, continued in Greek, Arabic and Latin treatises, had dictated the sexagesimal subdivision. In view of this situation it seems natural that Roemer should have adopted sixty divisions for his thermometer. (Indeed, in this respect there was precedent for his action; almost a century earlier Telioux, a Roman engineer, had superimposed the sexagesimal subdivision upon a primary scale of eight degrees.) Roemer consequently designated his lowest and highest temperatures as 0 and 60, respectively. He noted that on this basis water froze at about $7\frac{1}{2}$ or 8 degrees, and that normal body temperature was approximately $22\frac{1}{2}$ degrees; and Roemer checked the calibration of his thermometers through the use of these intermediate or secondary fixed points.

The scale of Roemer never secured wide recognition, but it formed the basis of another one which did. Fahrenheit in 1708 visited Copenhagen and there found Roemer calibrating thermometers. As a result he was led to adopt the same fundamental principles in his own work, with but minor changes. He chose the same minimum point as Roemer; but inasmuch as Fahrenheit was a maker of scientific instruments whose attention had been directed to thermometry through meteorology, he preferred to take body temperature as his upper limit. Then too he found Roemer's sexagesimal subdivision too gross, so that Fahrenheit subdivided each of its sixty subdivisions into four parts. The freezing point of water thus became 4×8 or 32, and body temperature $4 \times 22\frac{1}{2}$ or 90. Later he changed the scale slightly so that normal body temperature should correspond to 96 instead of 90. On this modified scale he found incidentally that water boiled at 212 rather than 240. "Fahrenheit" thermometers to-day are calibrated more accurately on the basis of the freezing and boiling points of water, so that Fahrenheit's upper fixed point, body temperature, is now only an incidental intermediate point, at 98.6. Such successive modifications have served to conceal the sexagesimal subdivision in which our common or Fahrenheit measure of temperature originated. A recognition of this Babylonian basis will make clear that the figures 32 and 212 are not simply the result of an eccentric or capricious arbitrariness but represent vestiges of an ancient scale of numeration. However, the decimal system (represented by the Centigrade thermometer) appears to be in a fairer way to efface this remnant of Babylonian influence in thermometry than to displace it in the older fields of angle and time measure.

CARL B. BOYER

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IMMUNITY AND RESISTANCE

IT is my earnest hope that Dr. Rivers's statement,[1] "Immunity is resistance to infection or injury . . . ," will help to arouse extremely high resistance to the synonymous use of the words "immunity" and "resistance." They have been used interchangeably by other writers, especially in medical publications, but that does not prove that it is desirable or proper usage. Each can serve us most satisfactorily if used to convey the idea indicated by its derivation. The word "immune" means free or exempt from any certain thing. The word "resistant" correctly used means that the object, either living or dead, offers appreciable oppo-

[1] Thomas M. Rivers, SCIENCE, 85: 107, 1942.

sition to whatever is endeavoring to attack or to overcome it, and the amount of such opposition may be slight or great. "Resistance" properly does not and should not convey the idea of complete exemption or freedom from any infectious agent or from disease in man, animals or plants. An organism may be immune from disease in the sense of distinct injury and not be immune from the infectious agent. It is true that an organism may be immune or resistant only under certain conditions, and we have to recognize the factor of biological variations. The two words "immunity" and "resistance" are not legitimately commutable and should not be used synonymously. The word resistance is too useful in its original meaning for indicating that the force (virus in this case) encounters a clearly evident degree of opposition on the part of the host either to the process of infection or to the injurious effects which might be expected to follow such infection. The word "immune" should be reserved for those cases in which there is no evidence of disease or in which the infectious agent is unable to establish itself in the host.

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VITAMIN A FOR COLOR-BLINDNESS

PUBLICITY given in the press to our report to the Southern Society for Philosophy and Psychology has resulted in a flood of inquiries which make it desirable to summarize our results for the benefit of the scientific public, omitting the study by the junior author (now in process of publication) which led up to the practical work.

(1) We have found it desirable to administer Vitamin A in doses of 25,000 units. Most cases are cleared up in from three to eight weeks by one dose per day.

(2) Administering 50,000 units per day seems to accelerate the cure; but upset some digestive tracts. We suggest to inquirers that they take one dose (25,000 units) after breakfast, and a second dose after dinner. If digestive trouble results, to reduce to one dose per day.

(3) By "clearing up" a case, we mean enabling the patient to pass a standard color-vision test on which he has previously failed. The tests involved are chiefly of the chart type (Stilling, Ishahara, etc.), administered in the naval and air services. Performance on worsted tests, however, are likewise made normal.

(4) We do not know how "permanent" the cures are. That is a matter for further research.

(5) We find, so far, no clear correlation between color-blindness and diet; nor have we definite evidence as to the effects of past infectious disorders.

(6) Color-blindness, of the so-called "red-blind" type, obviously is not the simple "sex-linked Mendelian character" which popular theories have assumed it to be. Apparently, the causes of the condition are complex.

(7) Persons who, when tested, are found to be color-blind, but who have not known it, may now reasonably be suspected of not having been color-blind very long.

KNIGHT DUNLAP
ROBERT D. LOKEN

UNIVERSITY OF CALIFORNIA
AT LOS ANGELES

SCIENTIFIC BOOKS

DIMENSION

Dimension Theory. By WITOLD HUREWICZ and HENRY WALLMAN. 165 pp. Princeton University Press. 1941. $3.00.

A DESCRIPTION of a geometrical object has to include a list of properties concerning curvature, convexity, connectedness, etc. First in any such list, however, would have to be a specification whether the object is a solid, a surface or a curve.

If the object is simple, then this basic question concerning its geometric nature can easily be answered. The dimension of a simple object can, for instance, be characterized as the least number of parameters needed to describe its points.[1]

Up to the seventies of the last century all objects of geometry were so simple that their points could be described by parameters and equations. However, with the tremendous extension of the domain of geometry due to Cantor's theory of point sets innumerable entities were introduced which are far beyond the reach of these simple methods. They are defined by joining and intersecting infinitely many cubes and squares, by various successive approximations and limit processes, some even by processes involving infinitely many unspecified choices. Naturally, to most geometrical objects of this enormous domain the classical characterization of dimension in terms of numbers of parameters is completely inapplicable.

[1] *E.g.*, one parameter, t, is sufficient to describe the points of the circle $x = \cos t$, $y = \sin t$. Two parameters, u and v, are needed for the description of the sphere in the usual representation $x = \sin u \cos v$, $y = \sin u \sin v$, $z = \cos u$.

Yet we are as interested in the dimension of the more complex entities as we are in that of simple figures, and we unhesitatingly classify many of them as solids, surfaces or curves.

To formulate the intuitive difference between these three classes one can devise a simple experiment whose outcome depends upon the dimension of the object to which it is applied. We cut out from the object a piece surrounding a given point. If the object is a solid we need a saw to accomplish this, and the cutting is along surfaces. If the object is a surface a pair of scissors suffices, and the cuts are along curves. If we deal with a curve we may use a pair of pliers and have to pinch the object in dispersed points. Finally, in a dispersed object no tool is required to perform our experiment, since nothing needs to be dissected. This characterization of dimension leads from n-dimensional to $(n-1)$-dimensional objects. It ends with dispersed sets, naturally called 0-dimensional, and, beyond these, with "nothing," in set theory called the "vacuous set." It is therefore convenient to consider the latter as -1-dimensional. The rigorous definition of dimension, starting with the -1-dimensional vacuum, reads as follows: A space is at most $(n-1)$-dimensional if each point is contained in arbitrarily small neighborhoods with at most $(n-1)$-dimensional boundaries. It is n-dimensional if it is at most n-dimensional without being at most $(n-1)$-dimensional.

During the last two decades an extensive theory has been derived from this definition. The need of an up-to-date exposition of dimension theory has been urgent for some years. Hardly any one is as well qualified to write such a summary as is Witold Hurewicz, who from the time of his Vienna doctoral thesis in 1925 has brilliantly contributed to the development of this branch of modern geometry. His collaborator, Henry Wallman, is noted for recent work in topology.

Their exposition, which is unsurpassed in elegance, covers not only most of the important results of dimension theory, in particular those of recent origin, but also discusses related topological questions. Concise definitions of even the most primitive concepts of topology are to be found in the text or in the alphabetical index at the end. The book can therefore be recommended as an excellent introduction into modern topology.

An introductory chapter outlines the development of the dimension problem and various approaches to its solution. The next chapters develop some of the results obtained before 1928. In several cases (in particular, with regard to the so-called local dimension) the proofs yield stronger statements than the authors actually formulate in their theorems.

Chapter IV contains a new proof of the fact that the n-dimensional space of analytic geometry is n-dimensional in the sense of dimension theory. The last section of this chapter is devoted to spaces of infinitely many dimensions. In the opinion of the reviewer this is a branch of dimension theory promising many important applications in the future since, so far, in the theory of functional spaces and operators dimension theory has received less attention than it deserves.

On the other hand, dimension theory has applied with great advantage functional spaces, as is shown in Chapter V, containing the theorem that each n-dimensional space can be topologically embedded into (*i.e.*, is homeomorphic with a subset of) the $(2n+1)$-dimensional Euclidean space. For instance, each curve (even a curve contained in a space of infinitely many dimensions) can be topologically embedded into our 3-dimensional space, each surface into the 5-dimensional Euclidean space, etc. While it is easy to construct a curve which can not be embedded into the plane, it was difficult to prove the existence of a surface which can not be embedded into the 4-dimensional space, and, in general, of an n-dimensional complex which can not be topologically embedded into the $2n$-dimensional space. That A. Flores' solution of this problem is only mentioned and not reproduced in "Dimension Theory" will be regretted by many a reader of the book, and the same may be said about Pontrjagin's example of two 2-dimensional spaces with a 3-dimensional product. The elaboration of these important examples would have been worth a few additional pages.

Chapter VI discusses mappings of spaces on the n-dimensional sphere and ends with very simple proofs of such classical results as the Jordan theorem for the n-dimensional space generalizing the fact that the 2-dimensional space (*i.e.*, the plane) is disconnected by the omission of the topological image of a 1-dimensional sphere (*i.e.*, a circle). After a short discussion of dimension and measure, a last chapter contains an excellent introduction into homology theory relating topology (and dimension theory) to algebra.

An appendix explains why the authors have restricted the development of dimension theory to separable metric spaces. Extended to still more general spaces the concept of dimension mentioned in this review has some rather strange properties, while the extension of similar definitions, as Wallman recently discovered, leads to almost unbelievable paradoxes.

We speak of a function of sets in a space if with each subset of the space (or at least with each subset of a certain kind) a number is associated. Dimension

is such a function of sets in a Euclidean space, measure is another one. The book ends with the question as to which properties characterize dimension among all possible functions of sets. It is to be hoped that this remark may, as many other remarks of the book undoubtedly will, stimulate further research in this difficult but really fundamental field of modern geometry.

KARL MENGER

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CHEMISTRY

Principles of General Chemistry. By STUART R. BRINKLEY. Third edition. x + 703 pp. New York: Macmillan Company. August, 1941. $4.00.

IN comparison with the second edition (1933) of this well-known college text, this new one offers some changes in the order of the topics in the introductory chapters, to render more effective the scientific deductions which follow. In line with modern developments, increasing use is made of physico-chemical concepts in theoretical discussions and in their application to practical industrial processes. A chapter has been added dealing with the nucleus of the atom, artificial radioactivity, transmutation of the elements and nuclear fission. In other respects, also, the work has been brought up to date.

General Chemistry. By HARRY N. HOLMES. Fourth edition. viii + 720 pp. New York: Macmillan Company. June, 1941. $3.75.

OF the many books on general chemistry which have appeared during recent years, few have presented the subject with the charm and allure which characterize this new edition of Dr. Holmes's justly popular text. Simple, straightforward and clear, in its narration and discussions, it is not only easy but also exceptionally interesting reading. The innumerable ways in which chemistry concerns our lives, our industries and our civilization are illustrated by arresting examples. Any student who digests what this book contains will have acquired, in addition to his chemical knowledge, a surprising store of useful information and a pretty good general education.

The new material added to the third edition (1936) concerns the conception of electrovalence, covalence and coordinate covalence, nuclear chemistry, radiation chemistry, colloid chemistry, uranium fission, new achievements with giant cyclotrons, chemotherapeutic advances, etc., as well as the later developments in manufacturing chemistry (synthetic rubber, Nylon, etc.). Each chapter concludes with "Exercises" and "References."

MARSTON T. BOGERT

COLUMBIA UNIVERSITY

SOCIETIES AND MEETINGS

THE SECOND LAS CRUCES MEETING OF THE SOUTHWESTERN DIVISION

THE twenty-second annual meeting of the Southwestern Division of the American Association for the Advancement of Science and eight associated societies and institutions was held in Las Cruces, New Mexico, during the week of April 27. The associated societies were the American Association of University Professors, Clearing House for Southwestern Museums, El Paso Archaeological Society, Mathematical Association of America, New Mexico Academy of Science, Society for American Archaeology, State College Biological Society and White Sands National Monument.

Although there were those who felt the meeting should not be held because of the war emergency, the paid registration of ninety seems to have thoroughly proved the wisdom of carrying on. One objection to holding meetings at the present time is that most persons drive and now the rubber situation will keep them home. In answer to this, it is worth noting that about 40 per cent. of the papers presented were the product of teachers and research workers residing at the host institution. This situation is often overlooked, but during the months to come we are going to realize more and more the importance of taking scientific meetings to men and women who for one reason or another rarely have the opportunity of going to a meeting away from home. What is equally important is the necessity of vacations even during war times, and these can frequently be combined with business.

The New Mexico State College of Agriculture and Mechanic Arts, serving as host institution, was aided by the New Mexico State College Experiment Station, the U. S. Bureau of Plant Industry and the White Sands National Monument. The college was founded in 1889 when travel was by way of the "Jornada del Muerto" or by the Santa Fe railroad. It is located at State College, which lies at one corner of a triangle, having sides of three to four miles, the other corners being occupied by Las Cruces and Mesilla. To the east lie the Organ Mountains with one of the most beautifully serrated skylines to be found in North America. The country is rich in tradition and folk lore going back to the days when it was still beyond the United States and was a part of Old Mexico. The museum at Old Mesilla, a village of adobe buildings, is filled with historic articles associated with both the peaceful settlers and the bandits of old, such as Billy the Kid.

A large measure of the success of the meeting was due to the carefully selected local committee, headed by Professor C. W. Botkin. The meeting was officially opened by a welcoming address by J. W. Branson, acting president of the college, to which Dr. Wm. M. Craig, president of the division, responded for the association.

After-dinner addresses were given by Drs. John D. Clark and Donald D. Brand, of the University of New Mexico at Albuquerque, on "Conservation Since 1933" and "Observations on Certain South American Economies," respectively. The thirteenth annual John Wesley Powell Memorial Lecture was given in the Branigan Memorial Library in Las Cruces on Tuesday evening by Mr. Howard W. Blakeslee, joint Pulitzer Prize winner in journalism in 1937. Mr. Blakeslee, who is the science editor of the Associated Press, spoke on "Science Moves Ahead."

Most of the eighty-seven papers whose titles were printed in the program were delivered by the authors in person, but more urgent government assignments kept some from coming to Las Cruces. These titles showed the mark of war as well as of peace, ranging from "The Anatomy of Guayule," by Ernst Artschwager, of the Bureau of Plant Industry of the U. S. Department of Agriculture, to "A Preliminary Examination of Some Proposals for World Reconstruction," by Professor P. M. Baldwin, of the New Mexico State College. These papers were delivered in the four rather general sections of Biological, Mathematical, Physical and Social Sciences.

Both the palate and the artistic sense were given a rare treat on the occasion of the Wednesday noon Spanish luncheon at "La Posta" in Old Mesilla. "La Posta" is operated by the Griggs family, descendants of the pioneers, in the original adobe building made famous by its rare tradition and modern excellence. After the luncheon, Dr. Fabian Garcia, director of the Experiment Station and a native of Chihuahua, Mexico, told many interesting stories of the early days in the village, including many of his own personal experiences which were told partly in Spanish, partly in English.

Tuesday afternoon was devoted to an excursion to the "White Sands National Monument," fifty-four miles northeast of Las Cruces near Alamogordo, New Mexico. This largest of the rare gypsum deserts covers more than 600 square miles of snowdrift-like "sand" dunes consisting of sparkling white dehydrated calcium sulphate. Some of these dunes are over fifty feet high and are constantly being moved by the prevailing winds. Descriptive talks were given on the grounds by Dr. W. B. McDougall, of the Park Service, on the "History and Development of White Sands National Monument"; by Dr. S. B. Talmage, of the Department of Geology of the New Mexico School of Mines at Socorro, on "Gypsum on Tour"; and by Dr. F. W. Emerson, of the Department of Biology of the New Mexico Highlands University at Las Vegas, on "Some Biological Relations of the White Sands." After spending more than an hour climbing upon the dunes and sliding down the steep faces, the scientists with wives and children were thoroughly ready to do justice to the "Chuck Wagon Supper" which was prepared on the grounds.

On Wednesday evening Dr. Wm. M. Craig, retiring president, delivered his address on "The Rôle of Spectrography in National Defense," in the auditorium in Hadley Hall.

For those who stayed over on Thursday there was a choice of visiting the Jornada Experimental Ranges of the New Mexico College of Agriculture and Mechanic Arts and of the U. S. Forest Service, a trip to the Organ Mountains to study the native flora and fauna, the Conkling Cave and Bishop's Cap Mountain, or to El Paso, Texas, and Juarez, Mexico.

At the annual business meeting, Dr. H. P. Mera, of the Laboratory of Anthropology at Santa Fe, New Mexico, was chosen president, and Professor F. H. Douglas, of the Denver Art Museum, was chosen vice-president. New members of the executive council chosen were Dr. Wm. M. Craig and Dr. E. W. Haury.

Section officers elected for the coming year were:

Biological Sciences:

Dr. E. F. Castetter, *Chairman,* University of New Mexico.

Dr. Edna Johnson, *Secretary,* University of Colorado.

Mathematical Sciences:

Dr. Emmett Hazlewood, *Chairman,* Texas Technological College.

Dr. P. M. Swingle, *Vice-Chairman,* New Mexico State College.

Dr. H. D. Larsen, *Secretary,* University of New Mexico.

Physical Sciences:

Dr. O. B. Muench, *Chairman,* New Mexico Highlands University.

Dr. Parry Reiche, *Secretary,* Albuquerque, New Mexico.

Social Sciences:

Professor F. H. Douglas, *Chairman,* Denver Art Museum.

Professor W. W. Postlethwaite, *Secretary,* Colorado College.

The 1943 meeting will be held in Colorado Springs, Colorado, and the 1944 meeting in Phoenix, Arizona. An invitation to meet in Las Vegas in 1945 was received, but action was postponed.

FRANK E. E. GERMANN,
Executive Secretary-Treasurer
UNIVERSITY OF COLORADO

REPORTS

THE AMERICAN MUSEUM OF NATURAL HISTORY[1]

A GRATIFYING increase in visitor attendance and museum membership, the completion of many important exhibits, a splendid output of scientific publications and many additions to museum collections make 1941 a year of important progress. Merely to glance at the contributions of the scientific, educational and administrative departments to this annual report is to appreciate the extent and immense value of the work carried on in this institution.

Early in the year the trustees, through a Survey Committtee, commenced an investigation into the museum, and this work will be carried on by the Plan and Scope Committee of the scientific staff. Important changes in trustee and staff organization are being made to enable the museum not only to move towards a definite plan of development but to operate more efficiently within its limited budget. In these changes one salient fact is recognized, that the scientific staff gives the museum its importance not only in the fields of natural science but in general public recognition. The great collections, the exhibits, the educational work in schools and colleges all alike must be based upon the highest scientific standard and knowledge, which can come only from the men and women who compose the scientific staff. Better to enable this group to work, freely to express itself, and to create, develop and carry out great museum plans is the important aim of the trustees. Our scientists fully realize that the "ivory tower" aspect of science is a thing of the past, and that the whole work and development of our institution must be integrated with the life of the community and the nation.

This nation is dedicated to the principle of enlightening its citizens—free minds, not closed minds—free search for knowledge, not propagandized thought. Our great museums are repositories for knowledge; they not only germinate free thought but minister to man's insatiable desire to know more about himself and the world. Museums are one of the important social agencies wherein man develops his spiritual outlook, and in the total war in which this country is engaged the spirit of a free people must be nourished.

Concerning the war effort it is interesting to learn that the scientific staff is uniquely qualified to provide information for various governmental agencies and invaluable data for our military and naval forces. Thus, the museum will provide vital information on parasites prevalent in war; the importance of insects in war; rodent disease carriers; the distribution and habits of, and safeguards against, poisonous snakes; illustrations of tests used to determine the fitness of soldiers; the war terrain of various parts of the globe which have been studied and visited in person by our scientists and explorers; descriptions of inhabitants and tribal customs, of flora and fauna; charts of ocean currents in the Caribbean and other waters, and other topics. Of aid to pilots and ocean navigators is our Hayden Planetarium course in celestial navigation. Research conducted by the museum in past years provides knowledge of marine products useful in war time as well as marine forms dangerous to shipping. Knowledge of nature's incomparable camouflage system is useful.

The department of education, in addition to greatly extending its service within the museum, is planning the creation of portable school museums to be circulated in the New York area, this work to be done in cooperation with other museums receiving city aid; establishment of "Hobby and Craft Development Centers"; establishment of "Community Museums"; integration of museum materials to illustrate various aspects of war areas; and organization of a radio series dealing with the relation of natural science to war.

Above all, the museum is a house of refuge from the stress of wartime existence and as such will continue to provide relaxation, enjoyment and inspiration for an ever increasing number of people.

On behalf of President F. Trubee Davison, who is on active war service, and the Board of Trustees, I wish to express our deepest appreciation to the many hundreds of people who have given generously of their time, effort and means to carry forward the work of the institution.

A. PERRY OSBORN,
First Vice-president

[1] Annual report of the president to the trustees of the American Museum of Natural History and to the Municipal Authorities of the City of New York.

SPECIAL ARTICLES

THE RELATION BETWEEN NUCLEIC ACID AND GROWTH*

RECENT work employing isotopic techniques emphasizes that most tissue constituents undergo continuous synthesis and degradation. In view of the great biological stability of chromosomes in contrast to the variability of most other visible cell constituents, it is of interest to know whether their com-

* This is reprint No. 553 of the Cancer Commission of Harvard University.

ponents show relatively greater chemical stability as well.

Several investigations have recently been made on the turnover of nucleoproteins and nucleic acids in normal and malignant tissues, using radioactive phosphorus as a tracer. Hahn and Hevesy[1] found a slow but appreciable turnover of nucleic acid phosphorus in all rabbit tissues studied. In the case of normal rabbit liver two thirds of the nucleic acid molecules were unchanged after fifty days, whereas all other forms of organic phosphorus were entirely renewed in the course of a few days. Marshak,[2] in experiments with isolated nuclei, found a rapid turnover of phosphorus in the protein fraction of lymphoma and of resting liver, indicating to him a rapid synthesis and breakdown of nucleic acids in the nuclei of these tissues. The accumulation of P^{32} in lymphoma nuclei and the increment over resting liver observed in regenerating liver, he ascribes to mitotic activity. Tuttle, Erf and Lawrence[3] noted that the turnover rate of P^{32} in the "nucleoprotein fraction" of leukemic infiltrated mouse tissues was three to four times higher than in corresponding normal mouse tissues.

In the present experiments, 63 pure strain Slonaker rats weighing between 150 and 200 grams were injected intraperitoneally with neutral sodium phosphate containing 15 to 30 microcuries of radioactive phosphorus (P^{32}). Thirty of these animals were subjected to partial hepatectomy 24 hours before P^{32} injection. This interval was chosen because we have shown[4] that it takes this long for mitotic activity to begin. The rats were exsanguinated under ether anesthesia at six intervals between 6 and 72 hours after injection. For each determination the livers of three rats were pooled and ground in ice-cold saline. A small aliquot of the resulting liver protein solution was precipitated with cold 8 per cent. trichloracetic acid. This precipitate, subsequently freed of phospholipids,[5] we have called "total protein," and this corresponds to the "nucleoprotein" of Tuttle *et al.*,[3] and Kohman and Rusch.[6] From an aliquot of the trichloracetic acid filtrate, inorganic phosphorus was precipitated with an ammoniacal solution of magnesium and ammonium nitrates. Nucleic acid was isolated from the rest of the original liver protein solution by one of two procedures, Levene's[7] and Hammarsten's,[8] which was adapted to liver by omitting the calcium chloride precipitation. The protein remaining after the latter separation of nucleic acids is then freed of phospholipids[5] and termed "protein residue." All these fractions have been analyzed for P^{31} and P^{32}; results have been expressed as specific activities (P^{32}/P^{31}) of each fraction relative to the specific activity of the inorganic fraction of the same tissue.

The results of our experiments on resting liver (Fig. 1) show that the turnover of phosphorus in the nucleic acid fraction is very much less than in any other phosphorus-containing fraction. The "protein residue" has a rapid turnover of phosphorus, distinguishable from the slower rate of nucleic acid and from the faster rate of phospholipid. The "total protein," which contains both nucleic acid and "protein residue," has a rate of turnover intermediate between the two, and examination of Fig. 1 will show that only about half the "total protein" phosphorus is nucleic acid phosphorus. Other writers have assumed that nearly all the phosphorus of the trichloracetic acid precipitate (when free of phospholipids) is contained in the nucleic acids.[3,6]

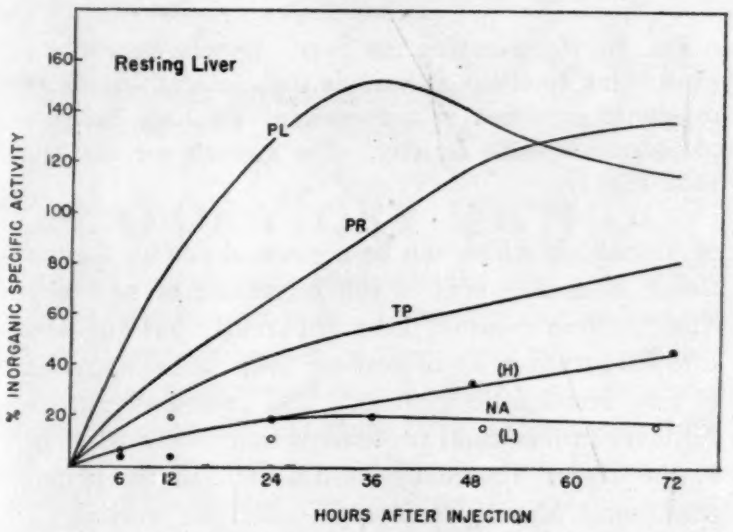

FIG. 1. Resting rat liver. Specific activities of phosphorus fractions at various time intervals after P^{32} injection, expressed as per cent. of the liver inorganic phosphorus specific activity. PL—phospholipids; PR—protein residue; TP—total protein (trichloracetic acid precipitate, free of phospholipids); NA—nucleic acids: (L) obtained by Levene's procedure (open circles); (H) obtained by Hammarsten's method modified (closed circles).

In regenerating liver, however (Fig. 2), the increased P^{32} uptake by nucleic acid is of an order

[1] L. Hahn and G. Hevesy, *Nature*, 145: 459, 1940.
[2] A. Marshak, *Jour. Gen. Phys.*, 25: 275, 1941.
[3] L. E. Tuttle, L. A. Erf and J. H. Lawrence, *Jour. Clin. Invest.*, 20: 57, 1941.
[4] A. M. Brues, D. R. Drury and M. C. Brues, *Arch. Path.*, 22: 658, 1936.
[5] Proteins were freed of phospholipids by successive 24-hour extractions with 1:3 alcohol-ether, hot alcohol and 1:3 alcohol-ether.
[6] T. P. Kohman and H. P. Rusch, *Proc. Soc. Exp. Biol. Med.*, 46: 403, 1941.
[7] P. A. Levene and L. W. Bass, "Nucleic Acids," p. 299, 1931.
[8] E. Hammarsten, *Biochem. Z.*, 144: 383, 1924.

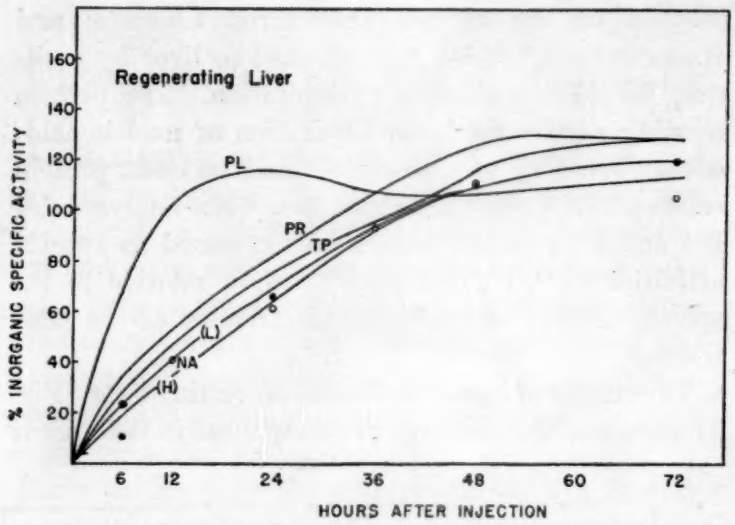

FIG. 2. Regenerating rat liver. Specific activities of phosphorus fractions at various time intervals after P^{32} injection, expressed as per cent. of the liver inorganic phosphorus specific activity. The symbols are the same as in Fig. 1.

of magnitude which can be accounted for by the synthesis of nucleic acid in the formation of new cells. The "protein residue" here apparently has the same rate of turnover as in resting liver, indicating little if any relation to growth. The increased rate of turnover in the "total protein" is therefore due wholly to the higher uptake by its nucleic acid component, confirming Marshak's interpretation on nuclei.[2]

Our results serve to point out the discrepancies between the results of Hahn and Hevesy[1] on nucleic acid and those of Marshak,[2] Tuttle *et al.*[3] and Kohman and Rusch.[6] We have confirmed the observation of the former workers that the turnover of nucleic acid in non-growing liver is very slow. The higher turnover rates found by analyses of "total protein"[3, 6] are not necessarily representative of the nucleic acid portion alone. The relatively higher turnover found by Marshak[2] in the nuclei of resting liver cells probably depends upon fractions of nuclear phosphorus other than nucleic acid phosphorus. Our methods do not distinguish cytoplasmic from nuclear nucleic acids, and some evidence has been obtained that the former have a higher rate of phosphorus turnover than the latter.[9] Thus the resting turnover of nuclear nucleic acids may be even lower than shown by our figures.

The present results lend chemical confirmation to the belief that the nucleus is the stable element in the cell, and point to the nucleic acid component as a compound ensuring this stability. Changes in the more labile compounds within the cell can readily occur through shifts in the steady state, in which rapid synthesis and degradation of these compounds are balanced. In the case of nucleic acids, such continuous turnover occurs very slowly, while synthesis takes place rapidly during growth. This distinguishing characteristic of nucleic acids may be of great importance for the mechanism of growth.

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[9] A. M. Brues, M. M. Tracy and W. E. Cohn, unpublished data.

ISOLATION OF A FILTERABLE VIRUS FROM CHICKENS AFFECTED WITH "BLUE COMB" DISEASE

FOR the past several years poultry pathologists throughout the Northeast have repeatedly encountered a disease entity in domestic chickens, and to a lesser extent turkeys, of unknown origin. It is referred to as blue comb, pullet disease, "X" disease and several other such terms referring to the symptoms exhibited or the conditions or time of encounter. Jungherr and Levine[1] have given a detailed description of the gross and microscopic lesions of the disease as well as their observations on its epidemiology and mortality rate. All attempts, with the possible exception of one by Bullis,[2] to transmit this condition from one bird to another of similar age have failed.

At the University of New Hampshire Agricultural Experiment Station in September, 1941, the writer had the opportunity of observing the course of the malady in two flocks in which the attack was extremely acute and severe. Many of the birds were found dead without having been observed sick; others died after an illness of only a few hours. From the blood stream of such acutely affected birds from both flocks we have been able to obtain a filterable agent that grows readily on the chorio-allantoic membrane of chick embryos. One strain has been carried through 56 transfers made at 72- or 96-hour intervals and the other strain through 39 such transfers. A third strain obtained from the eggs of an infected flock is now in its seventh transfer.

When the infected chorio-allantoic membrane, embryo or embryonic fluid are injected into susceptible chickens they, after 84 to 96 hours, become somewhat depressed and cyanotic. Death has not been produced by such an inoculation. If the inoculated birds are sacrificed at the end of 96 or 120 hours the following gross lesions may be observed; subcutaneous edema, generalized icterus, hemorrhages into the skeletal muscles, marked congestion and swelling of liver and kidneys, collection of urates in ureters, petechia-

[1] Erwin Jungherr and J. L. Levine, *Am. Jour. Veterinary Research*, 2: 4, 261–271, 1941.
[2] K. L. Bullis, personal communication, 1941.

tion of heart and serus coat of duodenum, sub-periosteal hemorrhage of flat bones, hemorrhage into the lungs and an acute catarrhal or hemorrhagic duodenitis. Various combinations of these lesions will be encountered. If the bird is not sacrificed the lesions will tend to disappear by the seventh day after inoculation. A microscopic examination of the liver of birds sacrificed at the end of 96 hours reveals foci of cloudy swelling. These swollen liver cells also reveal contracted pyknotic nuclei. The kidney changes are more pronounced but are also limited to foci. The epithelial cells lining the tubules show stages of degeneration varying from swelling with contracted pyknotic nuclei to actual destruction of the cells. The glomeruli are markedly swollen and contain few erythrocytes. There is round cell infiltration between the tubules in these foci.

A suspension of the feces and intestinal contents of experimentally infected birds is infective to other birds of the same age when given by way of the mouth. A bacterial free filtrate of the feces is infective when injected intraperitoneally. Bacterial free fecal filtrates are also capable of establishing the virus in incubating chick embryos. The virus is readily filterable through either or both the Seitz E-K 3 and the Chamberland-Pasteur L-3 filter.

Since this filterable virus alone does not produce death when injected into birds of a susceptible age we can not, at this time, say with any certainty that it is the sole etiological agent of the so-called "blue comb" disease.

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SCIENTIFIC APPARATUS AND LABORATORY METHODS

A SIMPLE ULTRACENTRIFUGE WITH PLASTIC ROTOR[1]

THE ultracentrifuge constructions presently in use are based either on the principle of the oil-turbine velocity centrifuge, equipped with mechanical bearings and a vertical steel rotor, or on the principle of the bearing-less "spinning top," which represents an air turbine floating on a cushion of compressed air. The analytical centrifuges of McBain and the concentration and optical centrifuges of Beams, Wyckoff and Pickels and Bauer are derived from the latter type. The most frequently employed rotor material in these constructions is duralumin.

During a recent visit to the Svedberg centrifuge laboratory of Professor J. W. Williams,[2] at the University of Wisconsin, it occurred to the writer that the use of materials of very low density for the construction of ultracentrifuge rotors might result in a considerable simplification of centrifuge design and obviate the necessity of employing expensive steel and aluminum alloys which are now difficult to procure on account of the National War effort. The first trials were made in Madison with 0.5 inches thick discs of polystyrene and of polyacrylic, transparent resins of 1.5 and 2 inches diameter, respectively. With the mechanical assistance of Messrs. E. Hanson and L. Henke these discs were transformed into simple air-turbines. Employing a 2-inch Lucite disc, tank nitrogen as propellant and a primitive optical set-up with a spectacle lens as objective, the sedimentation of aggregated earthworm hemoglobin within the cylindrical fluid cell was photographed with the kind help of Mr. Ch. Vilbrandt. Since the Lucite turbine showed no signs of irreversible deformation, even when spun for 10 minutes at approximately 40,000 r.p.m., the writer felt encouraged to continue these experiments with plastic rotors after his return to New Haven. A 2-inch Lucite turbine was accelerated to 57,000 r.p.m. with the aid of 80 pounds air-pressure per square inch, as measured with the Kahler-Hunt photoelectric speed-measuring circuit. After the mechanical features of the centrifuge had been improved in various respects, the construction of a 6-inch plastic turbine was undertaken with the mechanical aid of Mr. H. Nelson. Throughout the later phase of this work much benefit was derived from the expert advice of Professor F. W. Keator, of the Department of Mechanical Engineering, and several improvements, based on his suggestions, were incorporated in the design.

A schematic drawing of the centrifuge at its present stage of development is reproduced in Fig. 1.

The top speed, thus far attained with this model, has been 17,400 r.p.m. at 48 lbs/sq. inch air-pressure and an estimated free air flow of 40 to 60 cubic feet per minute, yielding a force of 20,200 times gravity at the center of the analytical fluid cell which is situated at a distance of 6 cm from the center of rotation. This speed is sufficient to cover practically the entire size range of plant and animal viruses as given by Stanley,[3] and, in general, to bring about molecular sedimentation, at appreciable rate, of protein particles from about 10^6 molecular weight upwards. As examples of such materials, the sedimentation of earthworm hemoglobin and of Stanley's crystalline

[1] This work was aided by a grant from The Jane Coffin Childs Memorial Fund for Medical Research.

[2] The writer wishes to thank Professor J. W. Williams for his hospitality and his encouraging interest in this work.

[3] W. M. Stanley, in Handb. d. Virusforschg., p. 538. Wien, 1938.

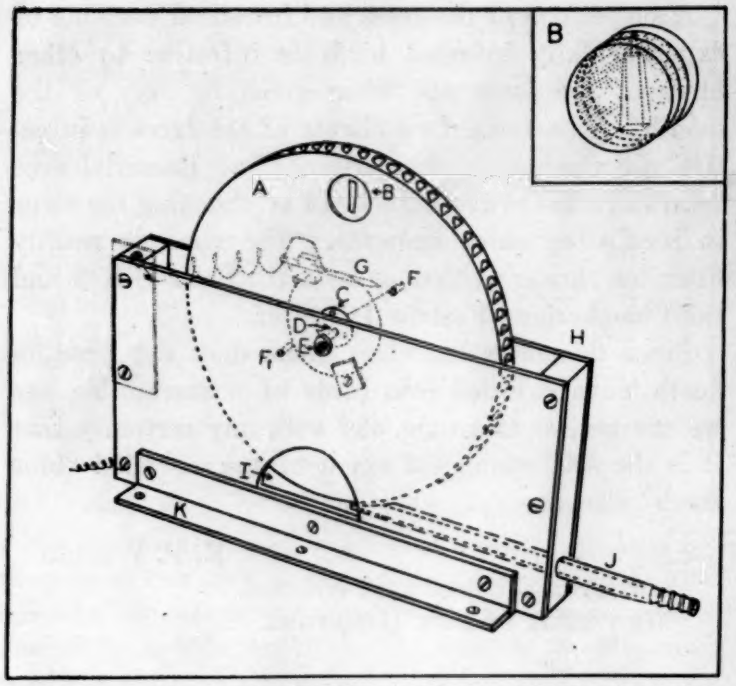

FIG. 1. Air-turbine Ultracentrifuge with Plastic Rotor. A, Lucite rotor, 0.5 inches thick, 6 inches diameter, with flutings milled into the periphery; B, analytical fluid cell (see below), inserted in cylindrical cell hole; C, brass disc, connected with similar disc on other side of rotor by brass bushing and screws; D, axle, made from 3/16 inches thick drill rod, fastened to C and turned down and surface-hardened at ends to fit E; E, Torrington needle bearing, 3/16 inches, mounted in casing, H, and carefully aligned with bearing on opposite side, F, F_1, brass contacts, inserted in rotor surface; G, contact brush, made from spring bronze, insulated from casing H, adjustable in position; H, centrifuge casing, made from sheet brass; I, semi-circular opening in casing, H, to permit free escape of expanded driving air; J, air-jet, 7/32 inches lumen, trumpet-shaped at inlet end and conforming with rotor shape at outlet end; K, angle for mounting on wooden base. Insert B, analytical fluid cell, made by cementing, with Lucite cement, two outer discs of colorless Plexiglas resin to central disc of red Plexiglas into which a sector-shaped opening of 12 mm. height and 3 mm. depth has been cut, connected with periphery by narrow drill hole, through which the solution under study is introduced with a hypodermic syringe. When in use, the cell is inserted into cell hole in rotor with the drill hole pointing towards the rotor center and the broad base of the sector pointing towards the periphery. During operation, the centrifuge is covered by a steel guard, made from 0.5 inch thick boiler plate by welding, equipped with openings opposite the cell holes and slots near the base to permit escape of air stream.

tobacco mosaic virus protein,[4] with sedimentation constants of $s_{20} = 60 \times 10^{-13}$ and 175×10^{-13} and molecular weights of 3×10^6 and 40×10^6, respectively, has been photographically recorded (Fig. 2), employing the 6-inch Lucite rotor.

The definition of the sedimenting boundaries, as

[4] The writer is indebted to Dr. W. M. Stanley for a sample of this material.

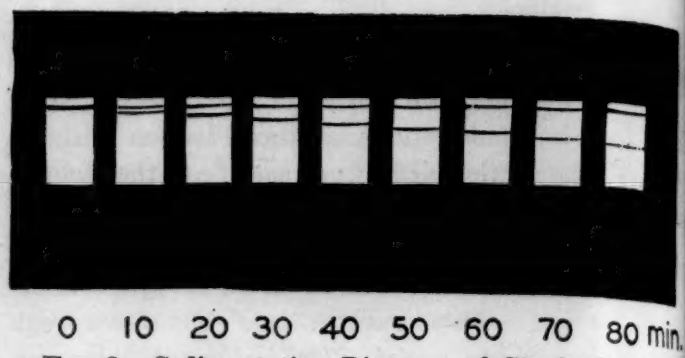

FIG. 2. Sedimentation Diagram of Stanley's Crystalline Tobacco Mosaic Virus Protein obtained with 6-inch Plastic Airturbine. 1 per cent. virus solution; 9,000 r.p.m. (5430 × g.); Toepler schlieren band method; 20 sec. exposures on Eastman contrast lantern slide plate; light source, Mazda 200 watt projection lamp; schlieren lens, Kodak projection lens, F = 4 inches; camera lens, Kodak anastigmatic lens, F = 4 inches.

exemplified in Fig. 2, the regular rate of sedimentation during the individual intervals, and the values of the sedimentation constants obtained for the virus with this centrifuge ($s_{20} = 157$ and 161×10^{-13}) as compared with that determined in our Beams ultracentrifuge ($s_{20} = 175 \times 10^{-13}$) for the same preparation, may be regarded as evidence that sedimentation in the plastic rotor proceeds essentially undisturbed by mechanical vibration or thermal convection currents.

The plastic rotors may be adapted to use in *centrifuge microscopes* as well as in *analytical ultracentrifuges*. The contact arrangement indicated in Fig. 1 (parts F and G) has been used to synchronize a stroboscopic light source (*e.g.*, Strobotak of the General Radio Company) with the rotor and to examine living cells during centrifuging with a low-power microscope.[5] In this manner, the stratification of Arbacia eggs has been observed with as yet not wholly satisfactory results.

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[5] The author is indebted by Professor N. E. Harvey for valuable advice and the loan of a Strobotak lamp.

NEW BOOKS

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SCIENCE NEWS

Science Service, Washington, D. C.

SEARCH FOR A NEW PLANET

A NEW planet about the size of Pluto but a little less distant may be added to the sun's family, which already contains nine members.

No such tenth member has yet been found, but the attraction of such a body would account for the three days' delay in the return of Halley's comet in 1910, according to the calculations of Dr. R. S. Richardson, of Mount Wilson Observatory, reported in the Publications of the Astronomical Society of the Pacific. He has told astronomers just where to look for the new body. It should now be found, he says, at about right ascension 16 hours, declination minus 20 degrees. These figures enable astronomers to point their instruments directly at the suspected spot.

At first, Dr. Richardson thought Pluto might be the culprit that held back Halley's comet. But it turned out that Pluto was miles away at the time—in fact, more than three billion miles away. This was the very closest the planet ever got to the comet, and it happened in October, 1901. Also Pluto is so tiny, only about as big as the earth! Finally, Dr. Richardson's very careful calculations showed that if Pluto had any effect at all, it was in the wrong direction; it would have hastened rather than delayed the comet.

Pluto moves in an orbit at a mean distance of 3,700,000,000 miles from the sun, which is nearly 40 times the earth's distance, 93,000,000 miles. Pluto's nearly circular orbit is so large that the whole of the long and narrow orbit of Halley's comet falls well within it, with a margin of about a billion miles. The comet requires 77 years to traverse its orbit, while it takes Pluto 248 years to get around its circuit.

What is needed to explain the comet's dilatory behavior, Dr. Richardson found, is a planet whose orbit just grazes the furthermost tip of Halley's orbit, grazes it by about 9,000,000 miles. The planet would be about the size of Pluto or the earth. A larger planet at a greater distance would also do the trick, but the planet must be small because otherwise it would have been discovered.

If this planet is found, it will be the third to have been predicted mathematically and afterwards discovered. The other two are Neptune, discovered in 1846 from the calculations of Leverrier and Adams, and Pluto, discovered in 1930 from the calculations of Lowell and Pickering.

THE CURVE OF A BASEBALL

THAT a baseball really does curve and may deviate from a straight line as much as 6½ inches at the home plate appears from measurements made by Frank L. Verwiebe, of Eastern Illinois State Teachers College, and reported in the *American Journal of Physics.*

These results run counter to the claims, made in *Life* magazine last September and supported by convincing pictures, that all "curves" are really straight and that the curves that many protested having seen are merely optical illusions. The results also contradict the assertion in *Life* that if there is any curvature at all, it occurs in the first half of the pitch, the last half being perfectly straight. The measurements here showed that most of the curving occurred during the last half, thus giving solid foundation for the "break" which so many insist they have seen.

The measurements were made in the same way that the path and the velocity of a bullet are determined. Four rectangular screens were set up between the pitcher and the home plate and one at the home plate. The five screens were crossed by vertical and horizontal threads, accurately spaced and aligned by a surveyor's transit. The position of the ball as it passed through each screen could be determined by the broken threads to within less than an inch.

One throw was intentionally straight, and the measurements showed that it really was straight. All pitches called as "curves" proved to be actually curved, the deviation from straight line travel varying from 2½ to 6½ inches as measured at the home plate. The outdrops deviated most, and are apparently the easiest curves to throw.

The speed of the ball was found to vary from 90 to 130 feet per second, requiring from half to two fifths of a second to travel the 50 feet from the pitcher to the batter's box. For a six-inch deviation, most of it occurring in the last fifth of a second, the ball must be traveling crosswise at two feet per second, which can easily give the batter the impression of a "break."

To cause a ball, launched horizontally at 130 feet per second, to rise requires that it be given enough spin to lift itself 7½ inches, this being the distance it would fall during the flight by gravity. This is very difficult, according to Mr. Verwiebe, although conceivably a Walter Johnson or a Bob Feller might give the ball a slight "hop." He concludes that many peculiar effects reported about baseball curves are still unexplained.

BOMBING A LAVA STREAM

BOMBING a lava stream to keep it from destroying a city is more or less like blasting a levee to relieve the pressure of a river in flood, except that a lava river builds its own confining embankments.

Lava of the type that Mauna Loa sent to threaten the city of Hilo early this month rapidly forms a crust on its outer surface as it flows, according to Dr. E. S. Shepherd, volcanologist of the Carnegie Institution of Washington. It not only builds up side walls but even roofs itself over.

This produces some impossible-appearing results, including the ability of the advancing stream to climb slight rises and to ignore side slopes that would deflect a stream of any normal, unconfined liquid. These confining walls of hardened lava crust are often thick—from six inches to two feet—but the rock is brittle and readily broken by heavy explosive charges. All that is necessary is to drop a few moderately heavy bombs—say 500-pounders—against the side wall at a point where the

break will permit the lava to drain down a slope into an unoccupied valley.

It is even possible, Dr. Shepherd said, to deflect such a lava flow with a firehose, by directing the stream on one part of the front to cause the more rapid formation of the confining crust there, permitting the lava to move in the desired direction at another point. The trouble is, however, that there is neither water nor firehose in most of the area ordinarily traversed by the lava flows of Mauna Loa.

Bombing volcanoes to provoke eruptions in enemy territory is not a very promising tactic. The biggest air bombs would probably have no effect at all if dropped directly into either Japanese or Hawaiian volcanoes, or indeed into any of the volcanoes in the whole Pacific region.

Only one type of volcano might conceivably have its outburst triggered by an outside explosion. That is one in which the lava column rises close to the very rim of the crater, and then hangs there for several days before beginning active eruption. If bombed at just that time, the outbreak might be speeded. Obviously, such an opportunity comes too seldom, and is never timed just the way an attacker might want it. Furthermore, the eruption might not destroy what you wanted destroyed. Better use the bombs directly on the military target itself.—FRANK THONE.

PAPERS READ AT THE MEETING OF THE AMERICAN ASSOCIATION OF CEREAL CHEMISTS

WHEAT germ may become the war diet substitute for cheese, beefsteak and the Sunday roast, it appears from experiments reported by E. L. Love and C. G. Harrel, of the Pillsbury Research Laboratory, Minneapolis, at the Chicago meeting of the American Association of Cereal Chemists.

Wheat germ protein, they found in diet experiments with laboratory rats, is as good as or better than casein, chief protein of milk and cheese, for maintaining growth. They conclude that it "can be used in the human dietary as a supplementary protein equal in value to casein or other animal proteins."

Animal proteins, from meat, fish, poultry, milk or cheese, have heretofore been considered better for human nourishment than proteins from plant sources such as vegetables and grains. But the "impending shortage of animal proteins" throughout the world due to the war makes the finding of an adequate protein from other sources particularly important.

The wheat germ protein, however, can not be obtained from ordinary bread, because this part of the wheat is discarded when flour is bolted. Bread made from unbolted, stone or water ground flour would contain the wheat germ and its protein. The germ of the wheat is discarded in flour milling because it also contains an oil which readily turns rancid.

THAT improved nutrition for the "uninformed and the unprogressive as well as to others at the trivial cost of 20 cents *per capita* per year" can automatically be attained through enrichment of bread and flour with the two vitamins, thiamin and niacin, and the mineral, iron, was pointed out by Dr. R. R. Williams, of the Bell Telephone Laboratory, who discovered a way to produce thiamin synthetically. Thiamin is vitamin B_1, also known as the morale vitamin. Niacin is the new name scientists have given to the pellagra-preventing vitamin.

Dr. Williams stated that something more than a third and less than a half of the nation's bread and flour supply is now being enriched, thanks to the cooperation of the milling and baking industries.

He listed obstacles to further advance as follows: (1) The highly competitive situation in low priced flours such as are used by low-income people has so far made such flours unavailable in enriched form. This is a definite challenge to the flour industry. (2) The public appreciation of the values of enrichment is still slight so that bakers find it difficult to recoup the costs of bread enrichment. This is a challenge to the nutritionists of the country. (3) Delay in the promulgation of final regulations for the enriched products retards progress.

BRAZIL

IN Brazil there is a mountain of iron darkening a tropical sky with twelve to fifteen billion tons of ore equal to the best produced by Sweden.

Through the Reconstruction Finance Corporation, the United States has loaned its sister Republic $14,000,000 for a railroad to carry that ore from the State of Minas Gerais to Port Victoria on the Atlantic Coast. Another loan, this time $20,000,000, will enable Brazil to build a steel plant at Volta Redonda in the State of Rio de Janeiro where the iron can be floated from Port Victoria, or sent by rail.

While Brazil is building the new steel plant, for which it is spending $25,000,000 of its own money, the rich ore can be shipped to U. S. smelters. We need Brazil's iron. With U. S. war production still below top peak, our steel industry is working at only 98 per cent. capacity.

In Brazil, too, are manganese, which puts backbone in steel, bauxite from which comes aluminum, commercial diamonds to grind the delicate mechanisms of bomb sights, beryllium for steel alloy, and graphite important to our crucible steel industry; and Brazil is the largest producer of chrome ore in the Western Hemisphere, another item in the manufacture of high-grade steel. In area and population, Brazil represents almost half of South America. She is the fourth largest nation in the world, and gifted with illimitable resources. Her merchant fleet is the second largest in this hemisphere.

The United States is already Brazil's best customer—in 1940 it took 42.3 per cent. of its total exports—and the U. S. search for raw materials for war is converting the South American republic into a new and mighty arsenal of strategic materials.

Our Army and Navy Munitions Board lists fourteen such materials "for which strict conservation and distribution control measures will be necessary." These materials are antimony, chrome, coconut-shell char, ferrograde manganese, manila fiber, mercury, mica, nickel, quartz crystals, quinine, rubber, silk, tin and tungsten.

Four of these—rubber, manganese, mica and bauxite—exist in potentially great quantities in Brazil. Already they have been streaming into the United States as fast as available ships can haul them.

Two other products are of special note: rubber and coffee. In the Amazon River Basin area between 200,000,000 and 300,000,000 wild rubber trees grow. Yet only one per cent., or 16,000 tons, of the world's total rubber supply comes from Brazil. United States and Brazilian rubber technicians hope that plants for development of Brazil's rubber potential, already begun, will enable that country to produce 30,000 to 70,000 tons, about 5 per cent. to 12 per cent. of normal U. S. needs.

Brazil is still the world's greatest coffee producer. It produces far more than it can sell—as a beverage. But coffee is a complex chemical, and a U. S. inventor has discovered a method for turning it into a plastic he calls "cafelite." The first coffee-plastic factory has been planned for operation in São Paulo with a capacity to transform 37,000 bags of coffee annually into plastics. If successful, this experiment will inspire large-scale plastic manufacture to eat into coffee surpluses; plastic goods can be used by civilians, releasing more vital chemicals for the manufacture of explosives.

EXPORTS OF TANNING EXTRACT

WITH Eastern Hemisphere sources hampered by the war, the United States is looking southward for the raw materials needed for tanning its growing Army's footwear.

Smiling hopefully under U. S. gaze is Peru, where the wild tara bush grows, and whose coastline is on the wrong side of the continent for Nazi submarines. Already tara from Peru has replaced sumac from Italy, balonia from Greece and myrobalams from India in tanning blends, used in this country.

Exports from Peru have risen rapidly in late years—490 tons in 1939 and nearly three times that amount in 1941, largely to the United States. It is now urged that plantations of tara be established on thousands of uncultivated acres along the west coast of Peru. Tara grows wild along the semi-arid foothills of the west coast. It bears a long pod filled with seeds. Pod and pulp which surround the seeds have a tannin content of 50 per cent. to 60 per cent. This is even higher than that found in sumac. Tara is further desirable because it imparts little color to the leather when used in treatment.

Economists of the U. S. Department of Commerce feel that if Peru will develop her production facilities, she will find a rich and permanent market in the United States. The tanning business in this country in 1939—the last peacetime year—was greater than that of all of Europe, including the United Kingdom.

ITEMS

A WARNING against use of the phenol-camphor mixture for athlete's foot by untrained persons is given in the current issue of the *Journal* of the American Medical Association. It is stated that a number of studies of the possible benefits and dangers of the mixture are under way. In the meantime it is recommended that its use be left to qualified physicians. Alternative mixtures of (1) equal parts camphor and phenol, or (2) three parts phenol and one part camphor were proposed in the December 6, 1941, issue of the *Journal* by Dr. Edward Francis (retired), of the U. S. Public Health Service. Dr. Francis warned against use of the preparation on wet skin.

To meet the present acute shortage of trained physiotherapists, a shortage expected to be intensified by the war, Columbia University will offer a two-year course starting next September. Physical therapy is a branch of medicine which treats disease by heat, sunshine, water, massage, exercise, mechanical devices and other physical measures. Since the first World War it has rapidly gained prominence. New techniques are being developed and more and more hospitals have installed special physical therapy departments for peacetime patients with ailments ranging from broken bones to paralyses and disturbances of blood circulation. Increasing numbers of trained therapists will be needed to give these treatments to speed recovery and rehabilitation of the war wounded.

THE growing need of manpower at the Colorado State Hospital for the Insane may be met by the assignment of conscientious objectors, as a possible preliminary test to assigning objectors to this type of work all over the country. A hospital for the insane is always undermanned, even in peace times, and the Colorado institution, with more than 4,000 patients, has lost many attendants. Five patients have escaped in recent days, and this is attributed to lack of manpower by Superintendent F. H. Zimmerman. Colonel Lewis F. Kosch, chief of camp operations of selective service, offered Dr. Zimmerman the use of 20 objectors from the Rocky Mountain camp near Colorado Springs. The men would be fed and uniformed by the hospital, and given an allowance of $2.50 a month each for incidental expenses.

AS a wartime security measure, all diathermy apparatus in doctors' offices, hospitals and elsewhere, including dealers' stocks, have been ordered registered with the Federal Communications Commission in Washington by June 8, in accordance with an order of the Defense Communications Board. The object of the order is to prevent subversive use of such machines by enemy aliens for radio transmission. Diathermy machines not only look like floor-model radios, but actually consist of radio transmitters choked off. They generate radio frequency energy designed for use in generating heat within the body tissues for treatment of various ailments.

AFTER a lapse of a couple of generations, hemp is again being cultivated in the United States, to make good the cutting off of our Asiatic import sources for cordage. The U. S. Department of Agriculture has bought and distributed about 3,000 bushels of hemp seed, enough to plant some 350,000 acres. Most of the planting will be done in Kentucky, where hemp cultivation started in 1775 and has survived on a small scale ever since. Hemp will also be grown in Wisconsin, Minnesota and Illinois. The acreage may be expanded into other states in 1943.